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DIAGNOSIS OF BONE TUMORS BY ASPIRATION*

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NEW YORK

IT is a fact well recognized by those who have occasion to deal with the problem of the treatment of bone tumors that a correct diagnosis is a matter of supreme importance. The treatment varies so widely in the different types of tumor, and in conditions simulating tumor, that it is essential that it be based on correct interpretation of the underlying pathology. Granting that clinical and roentgenographic evidence together enable us to make a correct diagnosis in the majority of instances, we are still faced with a considerable group of cases in which histological evidence is essential to avoid error.

Up to the present time material from tumors lying beneath the skin or mucous membrane has generally been obtained only by the use of direct surgical approach, i.e., by operative biopsy. The advantages and objections to this method have been stressed repeatedly by various authorities and it is not within the scope of this report to discuss them. Insofar as the operative biopsy is considered in relation to bone tumors, however, we feel that it must be regarded as a procedure not without risk. We do not advise it as routine, reserving it only for those few cases where the clinical and roentgenologic diagnosis is uncertain and a prompt decision as to the nature of the process is imperative.

While admitting that biopsy of bone tumors has, in numerous instances, resulted badly, chiefly owing to infection or fungation of tumor tissue through the biopsy wound, we believe that these bad results can largely be eliminated by greater care and a more thorough understanding of the proper technique, and that its advantages outweigh its disadvantages. Another method of obtaining material for histological study will hereinafter be described.

Histological study of tissue aspirated from a series of cases with tumors has already been reported by Martin and Ellis. Their results show that the information gained in this manner has been of unquestionable value in establishing a diagnosis.

The method they describe has certain definite advantages over the formal biopsy. Of these may be mentioned the simplicity of the technique of obtaining the material for study; the fact that it can be carried out in the out-patient or examining department with little inconvenience to the patient; that it permits of immediate operation or radiation therapy without the lapse of time necessary for wound healing, as is the case when a formal biopsy is performed; and finally that it obviates hospitalization and consequent expense to the patient.

Certain theoretical disadvantages may be claimed for this method. For example, in some cases no tissue is obtained at aspiration; in others, tissue cells are obtained but they cannot be identified as tumor cells. The possibility must be kept in mind that viable tumor cells may be implanted along the needle tract; or that in the case of vascular tumors intratumoral hemorrhage may result, affording the opportunity for tumor cells to become dislodged into the blood stream and cause distant metastasis.

*From the Department of Bone Tumors, Memorial Hospital, New York. Read before the Orthopedic Section, Academy of Medicine, April 20, 1931.

We have not seen instances of tumor implantation along the tract of the needle, or of dissemination of the tumor that could be attributed to the aspiration.

Martin suggested that the aspiration method might have a field of usefulness in the diagnosis of bone tumors. Accordingly, the Bone Department undertook this work in a series of cases, the results of which form the basis of this report.

ASPIRATION TECHNIQUE ADAPTED TO BONE TUMORS

We have included the description of the actual method of biopsy by aspiration by Martin and Ellis.* There are several points, however, in which the procedure differs from that used for soft part tumors.

The selection of the proper site for aspiration is more difficult in deeply situated tumors than in those on the surface. Aside from the anatomical relationships, central tumors are frequently encountered in which the bony shell may or may not be still intact. If radiographs show that it is broken at any point, it is advantageous to aspirate there. This was of particular importance in an aspiration of a tumor involving the neck of the femur. Radiographs showed that the cortex was broken on the upper side. With the proper position of the limb and angle of the needle, the procedure was relatively simple and a diagnosis of osteogenic sarcoma was obtained from the smear.

Novocaine infiltration of the skin and soft tissues is advisable before passing through to the deeply seated bone tumors. Adequate infiltration renders the procedure practically without pain.

A brief gas-oxygen anesthetic can be used if conditions warrant. It may be necessary in young or very nervous subjects.

There are several possible explanations for the failure to obtain cells. Some fibrous tumors, such as the osteogenic fibrosarcoma, may, by their texture, present great difficulty in aspiration. The technique may be faulty. It seems certain that practice is necessary in order to obtain a high percentage of positive results. There are several methods of utilizing the material obtained. If there is but a minute amount of tissue, the smear is the only suitable one. In case layer plugs of tissue in cylindrical shape are expelled from the needle, as may happen under ideal conditions, a portion of the tissue may be hardened in formalin and paraffin sections made in the usual manner. Many bone cases are extremely vascular and often yield what appears to be only blood. We find that if the blood clot is hardened and sectioned by the paraffin method tumor cells are frequently demonstrable. In the majority of the cases cited two or more of these methods were used as checks on one another.

The syringeful of blood may be expelled through a few thicknesses of gauze which filters out floating particles of tumor; these may then be transferred to glass slides and smeared or, if of sufficient bulk, may be hardened and sectioned.

We have included a series of 35 consecutive cases of bone tumors on which aspiration has been performed. In each instance we have tabulated the clinical diagnosis, the diagnosis from *x*-ray films, and the report of the pathologist, based on the material aspirated. In addition, a high percentage of cases has been proved by the histological report from gross material obtained later either at operation or autopsy.

It will be at once apparent that the small fragments secured by aspiration are often sufficient only to permit of the report that malignant tumor cells are present or absent. In other cases the type of tumor can be ascertained. The pathologist in many cases has been able to classify the tumor with striking accuracy.

One of the fields of greatest usefulness of this method lies in the differentiation between chronic inflammatory conditions and true tumors; for example, in one instance the report of "fibrin and pus" was the deciding factor in diagnosis in the case of an unusual tumor of the phalanx

* Biopsy by needle puncture and aspiration. *Ann. Surg.*, 92: 169–181, 1930.

of the thumb, about which we were most uncertain from clinical and roentgen-ray examinations.

ure (Case XXIX) occurred when an aspiration diagnosis was made of osteogenic sarcoma and the later biopsy showed

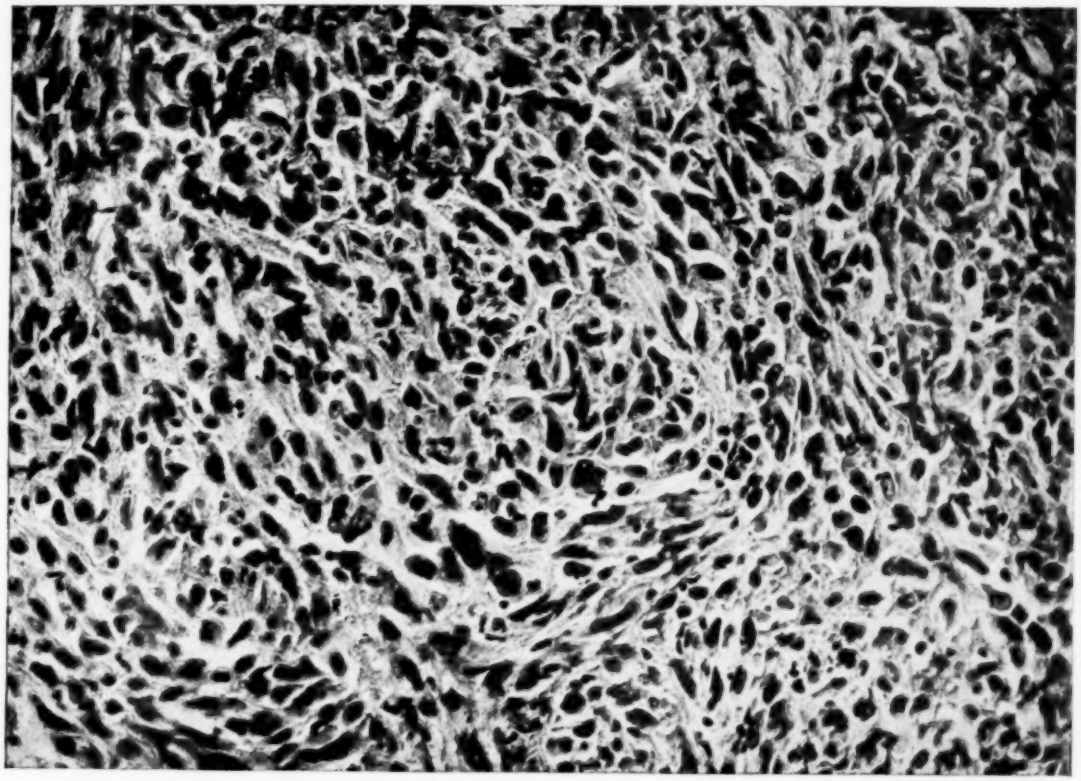

Fig. 1. Paraffin preparation of plug of tissue obtained at aspiration. Osteogenic sarcoma. Case IV.

Aspiration is adaptable to all types of bone tumors except those in which the tumor is deeply situated and surrounded by a zone of normal bone through which the needle cannot be made to penetrate. Fortunately, the majority of such tumors are susceptible of diagnosis without biopsy (most frequent examples of this type are giant-cell tumor, benign cyst, etc.). In a doubtful case the surgeon may have to resort to an operative biopsy.

As shown in Table 1, of the 35 cases in which aspiration biopsy was performed, the result was checked by subsequent operative biopsy in 12 and by paraffin sections of formalin-hardened clot obtained at aspiration in 3. In Case XXX the aspiration diagnosis was not supported by the findings at a subsequent operative biopsy, the diagnosis at aspiration being osteogenic sarcoma and at operative biopsy metastatic adenocarcinoma. Another failneurogenic sarcoma. In one case (XVII), the pathologist was unable to make a diagnosis.

Six cases have been selected from the series and are outlined briefly below in order to furnish a still better basis for a judgment of the advantages of this diagnostic procedure.

ILLUSTRATIVE CASES

Case IV. J. Z. A white male of fifty-seven years was admitted to Memorial Hospital November 11, 1929. The history started two months prior to admission with pain and swelling in the right shoulder which the patient attributed to a sprain. The swelling over the head of the humerus gradually increased in size.

Examination showed a well developed and poorly nourished man appearing chronically ill with marked loss of weight. There was a uniform swelling of the upper half of the right arm. In comparison with the left arm the

TABLE I

Case No.	Bone Aspirated	Clinical Diagnosis	X-ray Diagnosis	Aspiration Diagnosis	Operative Biopsy Diagnosis
I M. G.	Scapula	Osteogenic sarcoma	Malignant primary bone tumor	"Spindle cell sarcoma—periosteal or medullary osteogenic sarcoma"	Paraffin section of blood clot confirms diagnosis by aspiration (smear)
II S. S.	Ilium	Thyroid carcinoma metastasis	Carcinoma metastasis	"Malignant tumor"	Biopsy (from thyroid) confirms aspiration diagnosis
III N. M.	Mandible	Giant-cell tumor	Epulis	"Typical giant-cell epulis"	Biopsy confirms aspiration diagnosis
IV J. Z.	Humerus	Osteogenic sarcoma	Primary bone tumor	"Spindle cell sarcoma, i. e., osteogenic sarcoma"	Paraffin section of aspirated blood clot confirms diagnosis by aspiration (smear)
V A. F.	Phalanx	Question of inflammation or tumor	Giant-cell tumor	"Fibrin and pus; possibly tuberculosis"	Biopsy confirms aspiration diagnosis of tuberculosis
VI L. W.	Metatarsal	Malignant bone tumor	Medullary malignant tumor	"Malignant tumor—unclassified"	No biopsy
VII J. W.	Scapula	Primary bone tumor	Osteitis fibrosis cystica	"Rare spindle cells, suggesting sarcoma—no definite diagnosis"	No biopsy
VIII H. S.	Ilium	Osteogenic sarcoma	Osteogenic sarcoma	"Tumor cells present-type seen in benign giant-cell tumor unless clinically compatible would make no diagnosis"	No biopsy
IX J. D.	Ilium	Thyroid carcinoma metastasis	Metastatic carcinoma	"Looks like metastatic-carcinoma—no features of osteogenic sarcoma"	No biopsy
X P. V.	Superior maxilla	Tumor of antrum	Destruction of bone—carcinoma	"Osteogenic sarcoma—spindle cells—not a true bone former"	Biopsy confirms aspiration diagnosis
XI C. G.	Ilium	Osteochondrosarcoma	Osteochondrosarcoma	"Masses of atypical cartilage—unable to tell whether chondrosarcoma or chondroma"	No biopsy
XII I. G.	Rib	Endothelial myeloma	Endothelial myeloma	"Strongly suggests broken down endothelial myeloma"	Paraffin section of aspirated tissue confirms diagnosis on smear
XIII A. Y.	Clavicle	Endothelial myeloma	Endothelial myeloma	"Fibrin and pus—no tumor cells present"	No biopsy
XIV F. H.	Femur	1. Osteogenic sarcoma 2. Myosarcoma	Osteogenic sarcoma	"Large tumor giant cells—suspect myosarcoma"	No biopsy

circumference was 8 cm. greater. The tumor was hard and not movable over the humerus. The arm had only slight motion and that was accompanied by pain. Paget's disease of the bone was observed in the skull, left femur and tibia.

X-ray Report: "Films of the skull, left femur, pelvis and tibia reveal characteristic features of Paget's disease. Stereoscopic views of the left shoulder girdle reveal the presence of the same process in the clavicle, scapula and humerus. In addition a large area of bone destruction is noted in the upper third of the shaft of the left humerus."

Aspiration Smear: "Osteogenic sarcoma, spindle-cell type." This diagnosis was confirmed by a paraffin preparation of the aspirated plug of tissue obtained from the needle, as shown in the illustration.

CASE V. A. F. A white male of fifteen years was admitted to Memorial Hospital August 9, 1929. The history started one year prior to admission when the left thumb was sprained while the patient was catching a baseball. There was intermittent pain, but not severe enough to cause the patient to favor the hand. However, one week ago abnormal motion was noted and an *x*-ray showed a pathological fracture of the first phalanx of the left thumb.

Examination showed the left thumb to be diffusely swollen throughout the middle and proximal phalanges. This was most marked at the distal end of the proximal phalanx and it was here that abnormal painless motion was found.

Clinical Diagnosis: Osteitis fibrosa cystica.

X-ray Report: "There is a giant-cell tumor

Table 1 (*Continued*)

Case No.	Bone Aspirated	Clinical Diagnosis	X-ray Diagnosis	Aspiration Diagnosis	Operative Biopsy Diagnosis
XV L. B.	Superior maxilla	Carcinoma of antrum	Destructive tumor	"Chondrosarcoma"	Biopsy confirms aspiration diagnosis
XVI S. K.	Femur	Primary bone tumor	Osteogenic sarcoma	"Malignant giant cell tumor—relatively radiosensitive"	No biopsy
XVII C. R.	Ilium	Primary bone tumor	Bone involvement—not characteristic	"Unable to make any diagnosis"	Biopsy section—"probably osteogenic sarcoma"
XVIII S. B.	Clavicle	Primary bone tumor	Bone involvement—not characteristic	"Plasma cell myeloma almost certain"	No biopsy
XIX C. P.	Sternum	Osteogenic sarcoma	Osteogenic sarcoma	"Chondrosarcoma or chondroma"	No biopsy
XX P. Z.	Rib	Multiple myeloma	Extensive bone destruction	"Malignant tumor—unclassified"	Malignant tumor suggests plasma cell myeloma
XXI M. G.	Femur	Osteogenic sarcoma	Bone involvement—not characteristic	"Osteogenic sarcoma"	No biopsy
XXII S. P.	Skull	Metastatic carcinoma	Metastatic carcinoma	"Tumor cells present—type not determined	No biopsy
XXIII D. A.	Skull	Metastatic carcinoma	Metastatic carcinoma	"Carcinoma"	No biopsy
XXIV A. K.	Femur	Endothelial myeloma	Endothelial myeloma	"Tumor cells present—unclassified"	No biopsy
XXV A. P.	Jaw	Osteogenic sarcoma	Destruction of bone	"Cellular neoplastic osteogenic sarcoma"	Biopsy confirms aspiration diagnosis
XXVI B. M.	Fibula	Osteogenic sarcoma	Osteogenic sarcoma	"Osteogenic sarcoma"	Biopsy confirms aspiration diagnosis
XXVII P. M.	Rib	Chondrosarcoma	Chondrosarcoma	"Chondrosarcoma"	No biopsy
XXVIII N. C.	Sternum	Metastatic thyroid carcinoma	Destruction of bone	"Carcinoma"	No biopsy
XXIX M. R.	Right tibia	Fibrosarcoma	Osteogenic sarcoma	"Osteogenic sarcoma"	Neurogenic sarcoma Grade II. Aspiration failure
XXX G. G.	Sacroiliac region	Osteogenic sarcoma	Metastatic carcinoma	"Osteogenic sarcoma"	Metastatic adenocarcinoma. Aspiration failure
XXXI L. B.	Rib	Metastatic carcinoma—primary—undetermined	Extensive metastases in lungs and ribs	"Malignant tumor—most suggestive of metastatic carcinoma, but unwilling to diagnose on aspiration"	No biopsy
XXXII J. W.	Os calcis	Sarcoma of tibia	?	"Very cellular, highly malignant tumor—looks like endothelial myeloma"	Endothelial myeloma. Biopsy confirmation
XXXIII A. L.	Mandible	Giant cell tumor mandible	Osteogenic sarcoma	"Chondrosarcoma"	Biopsy confirms aspiration diagnosis of osteogenic sarcoma (chondromyxosarcoma)
XXXIV I. A.	Sternum	Carcinoma of thyroid with metastases	Metastatic tumor of sternum	"Malignant tumor . . . might be a thyroid tumor, spindle cell variety; some alveolar arrangements"	No biopsy
XXXV H. E. M.	Humerus	Osteogenic sarcoma	Osteogenic sacroma	"Osteogenic sarcoma"	Biopsy confirms aspiration diagnosis

of the distal half of the proximal phalanx of the left thumb with fracture, which does not involve the joint surface."

Aspiration: April 2, 1930, showed fibrin and pus; no tumor.

Biopsy: April 16, 1930, demonstrated tuberculosis.

Case III. N. M. A white male of seven years was admitted to Memorial Hospital November

20, 1929. The history started six months prior to admission with a toothache in the left lower jaw. The first molar tooth was extracted.

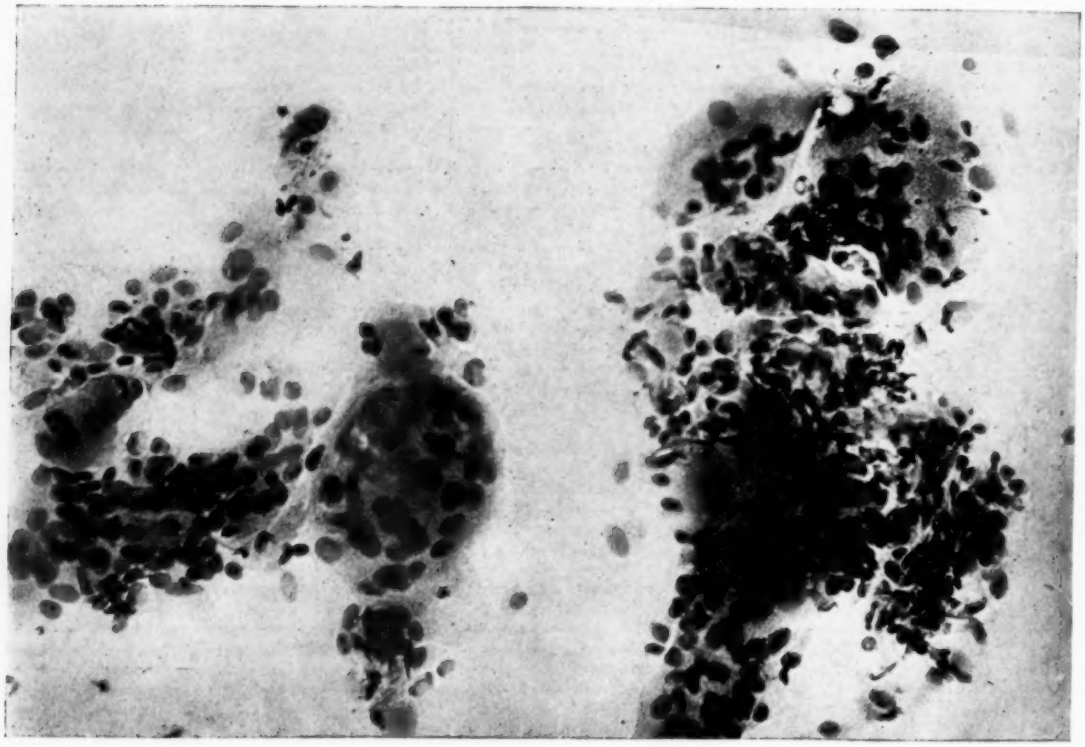

Fig. 2. Smear of aspirated material demonstrating a typical giant cell epulis. Case v.

Two months later the gum around the empty socket began to enlarge. In August, 1929, the tumor was excised and the wound healed quickly. There was an immediate recurrence.

Examination showed the left lower first molar, bicuspid and canine to be absent and in their place was a large, soft, purplish tumor.

X-ray Report: "Well defined rarefaction in the left mandible, as seen with epulis."

Aspiration: November 26, 1929, typical giant-cell epulis, as shown in the accompanying illustration. Biopsy performed two weeks later confirmed this diagnosis.

Case x. P. V. A white male of three years was admitted to Memorial Hospital April 29, 1930. The history started six weeks prior to admission with lacrimation of the right eye and subsequent swelling of the right cheek without pain.

Examination showed a moderate exophthalmos to be present without pupillary or retinal changes. The right cheek was swollen and particularly prominent over the zygoma where the tumor had bony hardness. The right naris was completely blocked. The oral cavity was negative.

X-ray Report: "The left antrum is markedly cloudy and its walls are irregular in outline. The appearance suggests extensive involvement. Diagnosis: carcinoma."

Aspiration smear under gas oxygen showed, "osteogenic sarcoma—spindle cells—not a true bone former." Biopsy performed ten days later confirmed this diagnosis.

Case xii. I. G. A white male of twenty-six years was admitted to Memorial Hospital September 9, 1929. The history started three weeks prior to admission with a cold. When the physician was examining the chest at that time he noticed a lump over the right eighth rib anteriorly. Two weeks later a pleuritic pain appeared in the region of the swelling. This pain was relieved by strapping.

On examination an ovoid tumor was found over the anterior end of the right eighth rib. It was approximately 4 cm. in diameter and had a slightly spongy texture.

X-ray Report: "Extensive destruction of the anterior end of the right eighth rib is noted in this film of the chest."

Aspiration Smear: "Strongly suggests broken down endothelial myeloma."

A paraffin section from the blood clot obtained at aspiration confirmed this diagnosis.

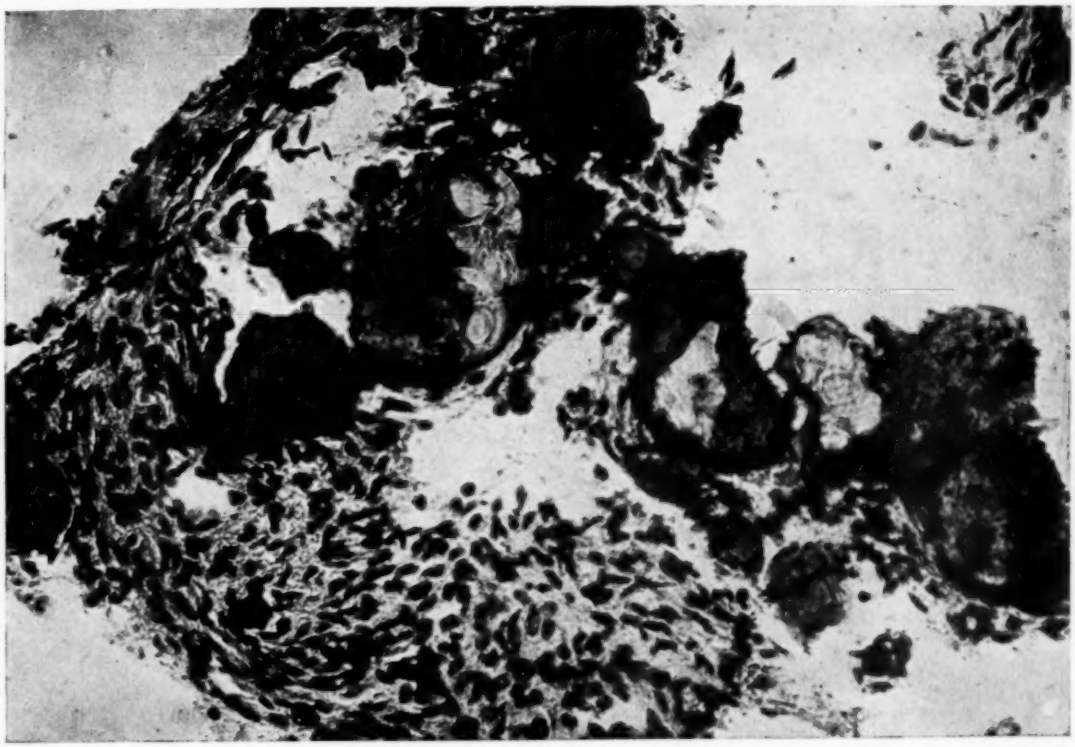

Fig. 3. Smear of aspirated material from superior maxilla showing osteogenic sarcoma. Case xi.

Case xx. P. Z. A white female of fifty-one years was admitted to Memorial Hospital April 4, 1930. The history started after an attack of influenza two years previously with pain in the right elbow which extended up into the shaft of the humerus. Four months before admission pain appeared in the neck and later in the ninth and tenth ribs anteriorly. Subsequent swellings appeared over right zygoma, right clavicle and third rib anteriorly.

Examination showed a poorly nourished female in great distress with generalized pains. There was external evidence of tumors over the areas mentioned in the *x*-ray report.

X-ray Study of Skeleton: "Bone destruction in left frontal and parietal bones, distal end of right clavicle, sixth left rib anteriorly and right zygoma."

The tumor of the right zygoma was aspirated and a diagnosis of blood and fibrin was made. Two weeks later the sixth left rib was aspirated and a report of malignant tumor, unclassified, was made.

The section of the rib removed later showed considerable productive osteitis. The marrow was filled in places with plasma cells and with the history the diagnosis was plasma cell myeloma.

For those who have not read the article by Martin and Ellis on Biopsy By Needle Puncture and Aspiration, we quote the following:

Technique: The special paraphernalia required is an ordinary 18-gauge needle 5 to 10 cm. in length (which should be new and sharp) and a 20 c.c. Record syringe. For the preservation of the specimen glass slides and a specimen bottle with 10 per cent formalin are needed.

The skin at the site of the intended puncture is painted with iodine and a small area of skin infiltrated with 1 per cent novocaine. With a bistoury pointed scalpel (No. 11 Bard Parker blade) a stab wound is made through the skin with the instrument held at right angles to the skin surface. This puncture of the skin facilitates insertion of the needle. An 18-gauge needle attached to a tightly fitting Record syringe is then inserted and advanced slowly through the superficial tissues until the point is felt to enter the suspected neoplastic mass. Guided by

palpation with the disengaged hand, it is striking how readily a difference in consistence of the tissues can be felt as the needle enters a mass of neoplasm. When the point of the needle is felt to enter the tumor, the piston of the syringe is partly withdrawn so as to produce a vacuum and the needle slowly advanced 1 to 3 cm., depending on the anatomy and size of the tumor. Maintaining the vacuum, the needle is then withdrawn to the same distance and advanced again. This manipulation may be repeated two or three times at the discretion of the operator, care being taken to maintain the vacuum when the needle is advanced or partly withdrawn. Aspiration with the needle at rest is not sufficient to draw tissue into the needle in most cases. By advancing the needle and aspirating simultaneously, a plug of tissue is both forced and drawn into the needle. Maintaining suction during partial withdrawal detaches the plug of tissue already within the needle. We have found this detail to be very essential. Before the needle is completely withdrawn from the tissue, the piston must be slowly released until the pressure in the needle is equalized, or better still, the syringe detached and the needle withdrawn separately, otherwise the aspirated material will be suddenly drawn and splashed over the interior of the syringe, making its collection difficult. While the needle is being advanced and withdrawn under negative pressure, a small quantity of blood mixed with fragments of tissue may enter the syringe, or a solid cylindrical mass of tissue may appear. In other cases, especially in the firmer masses, the syringe apparently remains empty, but after withdrawal, the needle is usually found to contain a plug of tissue.

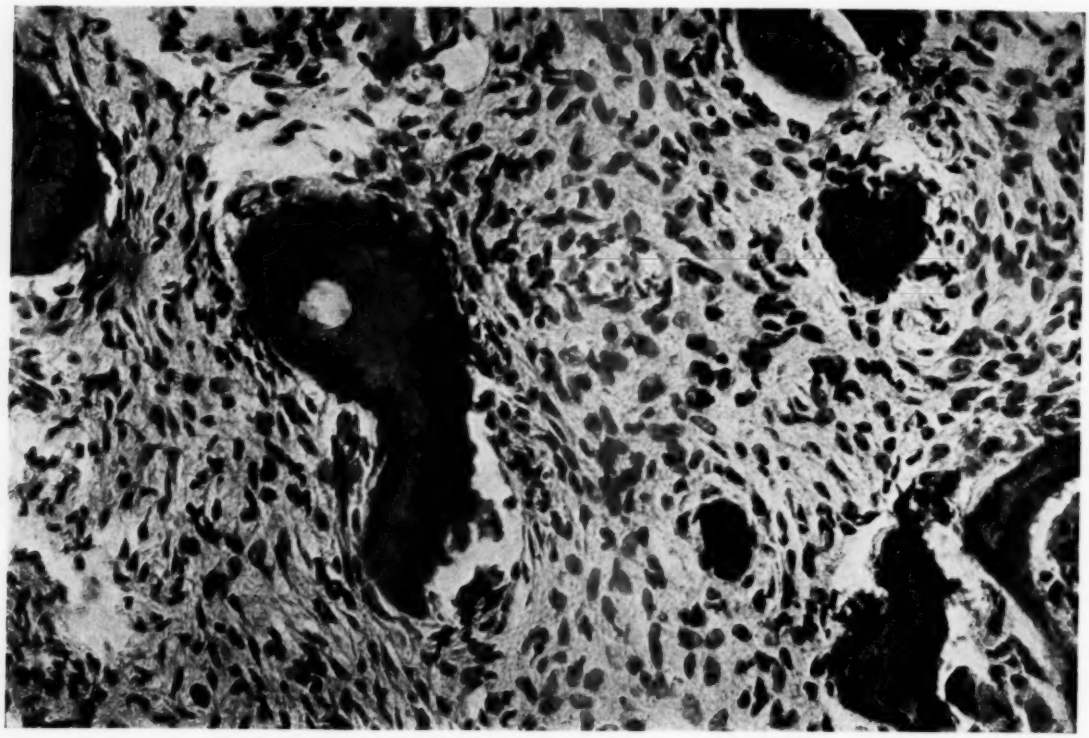

Fig. 4. Biopsy preparation showing histological similarity to preparation obtained by aspiration method.

After complete withdrawal of the apparatus, the syringe is detached from the needle, filled with air, attached and the contents of the needle slowly and carefully expelled on a glass slide. A small fragment of tissue should be left on the slide for smearing, and the remainder placed in the specimen bottle for fixation and staining by regular methods. If the needle is empty, small masses of tissue can almost always be found mixed with blood in the syringe, and these should, if necessary, be very carefully searched for. One or two of these small masses can readily be fished out upon a glass slide for smearing and immediate staining. In any case where the syringe contains blood or any tissue, formalin from the specimen bottle

is poured into the open barrel of the syringe, agitated and returned to the specimen bottle.

8. Mount with Canada balsam and cover glass.

Longer Method. The remainder of the specimen is treated as any small biopsy, being carried through the stages of alcohol fixation and embedding in paraffin, great care being taken to collect and mass every minute particle of tissue, since a positive diagnosis may often be obtained from the smallest fragment. Absolutely fresh 52° – 56°C. paraffin should be used for embedding, and all particles massed together on the blook and cooled immediately on ice. Every section cut from the block should be examined for fear that in dealing with such small particles, one might lose the opportunity of making a positive diagnosis. We usually cut six to eight sections and place them on a single slide. These are carefully examined and further sections cut if the first are negative and more material remains on the block.

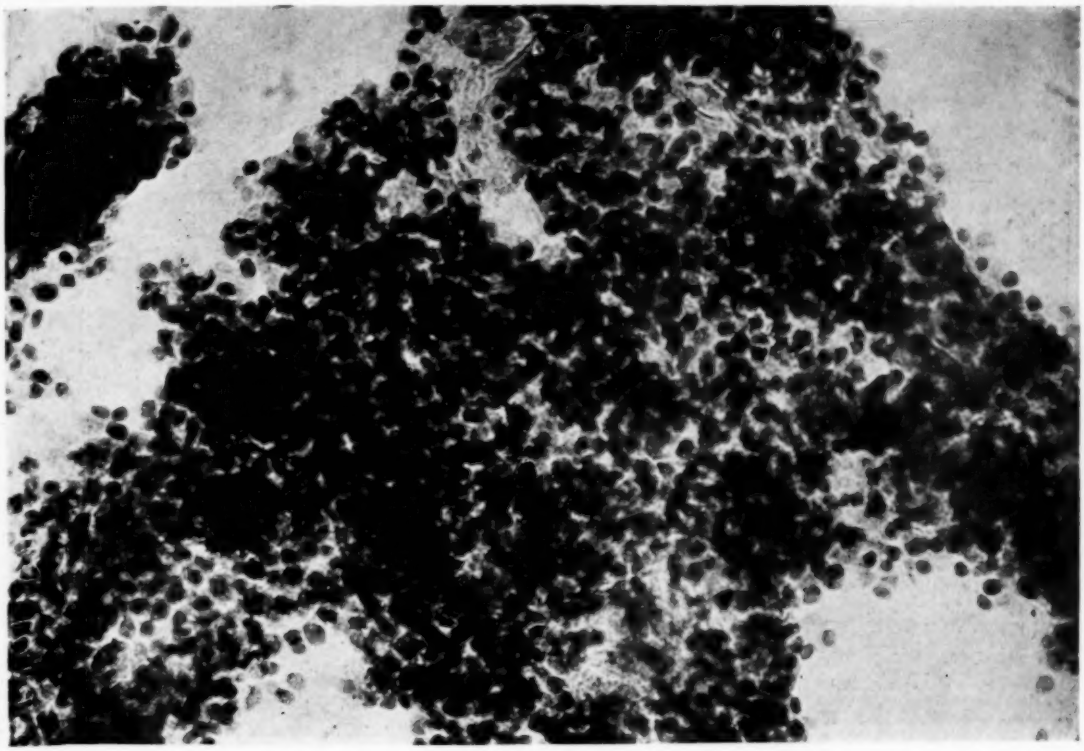

Fig. 5. Smear of aspirated material demonstrating broken down endothelial myeloma. Case XIII.

LABORATORY TECHNIQUE

In the preparation of the specimen for study we have followed the technique described by Martin and Ellis and quote in full as follows:

Preparation of the Specimen. In the average case, we have examined the material obtained by two methods: The shorter (a technique devised by one of us (E) has the advantage of a reading in six to eight minutes and the longer, the advantage of a fixed and cleared preparation.

The Immediate Method. The fresh tissue fragment on the glass slide is smeared by very firm flat pressure by another slide drawn once across. The smeared slide is fixed by heating gently over a gas flame until warm and dry, and is then prepared according to the following technique:

1. Alcohol (95 per cent)—one minute.
2. Water—one minute.
3. Hæmatoxylin—one minute.
4. Water—one minute.
5. Eosin—one minute.
6. Alcohol (95 per cent)—one-half minute.
7. Carbolxylol—one-half minute.

In case a reading is desired earlier than by our routine laboratory technique, we use the following method of preparation which requires about three hours:

The quick paraffin method:

1. Formalin 10 per cent—ten minutes.
2. Alcohol 95 per cent—two changes, ten minutes each.
3. Xylol—two changes, one-half hour each.

4. Paraffin 54°C.—two changes, one-half hour each. (First three steps in incubator 37°C.)
5. Cut and stain.

operation or biopsy was the original aspiration diagnosis found to be in error. This method is described with due appre-

FIG. 6. Aspiration smear reported as malignant tumor, unclassified. Subsequent biopsy was similarly reported. Case XXII.

CONCLUSIONS

Biopsy by the aspiration method is of value in establishing the diagnosis of bone tumors. It has advantages over the operative biopsy, but in our opinion will never completely displace it. In those cases in which the diagnosis cannot be made, even after several attempts, by the aspiration method, recourse can always be had to an operative biopsy. In those cases in which the pathologist is unable to differentiate the exact type of tumor present, it is of advantage to know whether the condition is neoplastic or inflammatory, malignant or benign. In only 1 case out of the 35 was the pathologist unable to make a diagnosis and in only 2 cases out of 16 which were subsequently checked by paraffin sections of tissue removed at

ciation of the dangers that may be inherent in its general adoption. The possibilities of error, the necessity for selection of cases for its use, and the unusual demands placed upon the pathologist is reaching conclusions from a study of such a small amount of tissue should be borne in mind. The latter consideration is the one which is most likely to limit its field of usefulness.

Finally, the writers wish to express their appreciation of the assistance given by the Pathological Department, Dr. Jamts Ewing, Director, and by Dr. Fred Steware, upon whom devolved the difficult task of making most of the diagnoses from aspirated material; and to acknowledge their indebtedness to Dr. Martin at whose suggestion this work was commenced and who was personally responsible for a number of the aspirations.

THE "ZIPPER STITCH" FOR UPPER ABDOMINAL INCISIONS*

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NEW YORK

I HAVE been asked to record a stitch which often facilitates closure of the deep layer in upper abdominal incisions. It is such a simple procedure that I had not thought it worthy of emphasis. Perhaps, too, it is not original. However, I shall describe it, since it often avoids trouble and is not generally known.

FIG. 1. Posterior sheath of rectus (after Deaver).

The posterior sheath of the rectus muscle above the semilunar line in made up of fibers from the aponeuroses of the internal oblique and transversalis muscles. These are so intimately fused that they constitute a single layer; and in close apposition to this layer are the transversalis fascia and the peritoneum (Fig. 1). In closure of a vertical incision through the rectus muscle the original suture is not of the peritoneum alone but of these combined structures. They are often tense, retracted and under tension. As a result, apposition of the edges is often difficult; moreover the sutures not infrequently tear out when the sutures are drawn snug or subsequently as the result of distention or straining. The failure of this layer to hold is the usual cause of the large percentage of incisional herniae in these incisions and the occasional occurrence of evisceration. When this distressing complication threatens, the patient complains of discomfort in the region of the wound and vomiting. Inspection of the wound may be negative or show a fullness; separation of the skin edges results in a considerable flow of salmon colored fluid. This, in my experience, always indicates a separation of the deep layer with a knuckle of intestine projecting between the edges. Under these conditions the patient should be taken to the operating room, the wound opened and resutured. If this is not done distention and straining follow and evisceration is likely to occur.

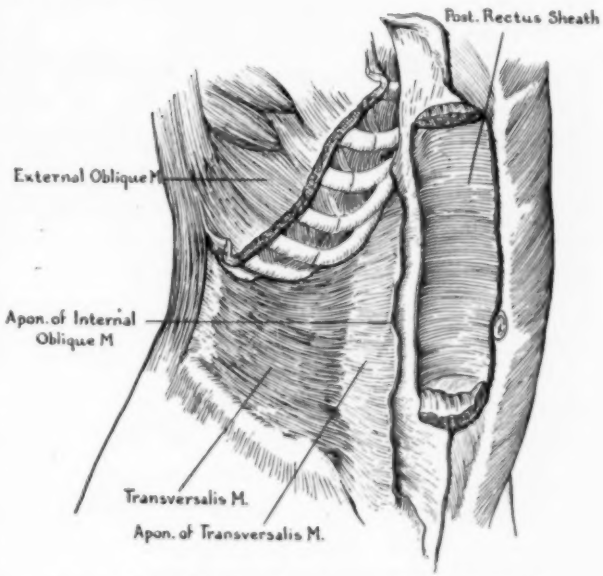

FIG. 2. Posterior sheath of rectus (after Deaver).

The anatomical structure of the posterior sheath is largely responsible for the ease with which this layer tears apart. The fibers of the aponeuroses of the internal oblique and transversalis are transverse and therefore offer no support for the sutures (Fig. 2). The layers, including the attached peritoneum, are taut and the muscles, being attached to the costal arch, are pulled outward with each respiratory movement. The widening of the costal

*Submitted for publication June 17, 1931.

arch pulls the muscles; the aponeuroses are proportionately drawn outward together with the attached peritoneum. The pull is

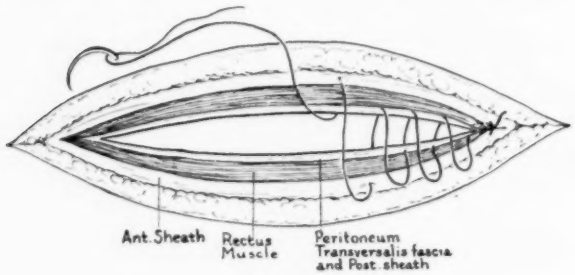

FIG. 3.

resisted only by sutures and the deep ones have little support, being placed in tissues whose fibers are parallel to the direction of tension. It is obvious that the strain on this layer must be relieved by sutures placed through more resistant tissues. This is fully appreciated by all surgeons and is accomplished in various ways: for instance, by tension sutures through all layers, or passing the original suture every third or fourth stitch through the rectus and its anterior sheath. But even in these methods it is often difficult to approximate the deep layer.

I have found the following simple modification advantageous.

A double strand of No. 1 catgut is used. It first picks up the anterior sheath below the lower angle of wound. Having been tied the needle is passed through the rectus and posterior sheath including peritoneum. It is then passed back and forth from one edge of posterior sheath to the other 3 or 4 times and *left very loose.*

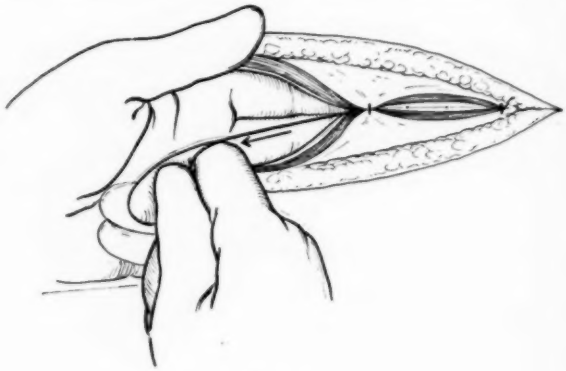

FIG. 4.

This is the important feature. It is then passed forward through rectus and anterior sheath across wound and inward through the opposite anterior sheath, rectus, posterior sheath and peritoneum (Fig. 3). Then the suture is slowly and forcibly pulled taut. The pull should be at a low level and in the direction of the incision, not at an angle. The strain is taken up by the resistant tissues of the anterior sheath, and the posterior sheath and peritoneum come together without strain (Fig. 4). The procedure may be termed the "zipper stitch." The suture may be continued with the same stitch, but in a very tense wall it is best to interrupt it. In this case the suture is passed out again and picking up the opposite side of anterior sheath is tied.

ACUTE GASTRO-MESENTERIC ILEUS*

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ACUTE gastro-mesenteric ileus, frequently referred to as acute dilatation of the stomach, is a form of obstruction caused by compression of the duodenum between the spine and aorta posteriorly and the mesenteric root anteriorly and results in dilatation of the stomach and the proximal portion of the duodenum.

The condition has been repeatedly described, but the symptoms are frequently overlooked, or their gravity is not appreciated.

Many lives will be saved by early diagnosis and adequate treatment.

Acute dilatation of the stomach was described by Duplay, a French writer, in 1833.

The mechanism of acute gastro-mesenteric ileus was recognized by Rokitansky in 1842.

Miller and Humby published the first case in the English literature in 1853.

Association with acute infectious diseases was observed by Baugerer in 1855, with injuries, by Erdmann in 1868, and complicating the post-partum state, by Kundrat, in 1891.

Analyses of case reports were made by Conner in 1906, Laffer in 1908 and Doolin in 1918.

INCIDENCE

The majority occur between the ages of twenty and thirty but no age is exempt. In Laffer's series, (117 cases) the extremes were nine months and seventy-five years.

It is slightly more prevalent among women than in men.

It may complicate operations, injuries, and acute or wasting diseases, as may be seen by the following statistics of 131 cases.

Following trauma	17
After operation upon the stomach	4
Upon the bile tract	15
Upon the kidneys	11
Upon the appendix	5
Upon the uterus	4
Curettage	4
Ovariotomy	4
Herniotomy	4
Other abdominal operations	9
Upon the extremities	11
During the Progress of Disease:	
Pneumonia	6
Appendicitis	4
Carcinoma of esophagus	3
Abscess of jaw	3
Localized tuberculosis	2
Miliary tuberculosis	2
Brain diseases	3
Spinal deformities (5 after application of plaster jackets)	11
During Convalescence:	
From typhoid	5
Acute rheumatism	2
Scarlet fever	1
Floating kidney	1

Miscellaneous conditions include errors in diet, charged drinks, inflating the stomach for diagnostic purposes and childbirth (Conner).

ETIOLOGY

Opinions differ as to whether the primary lesion is in the stomach or duodenum, but it is agreed that the distended stomach increases the incarceration of the duodenum and that gastric dilation may occur without involvement of the lower duodenal segment.

Paralysis from disturbance of innervation has been described and it has been shown that section of the vagi causes acute dilatation of the stomach in dogs, (Sheeds and Koenniche).

Postoperative intestinal paralysis has been studied by Cannon and Murphy who demonstrated the following:

Etherization for one-half to one and one-half hours and exposure of the intestines to the air, with unusual cooling, did not markedly impair the motor function of the stomach.

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Handling the intestines caused definite delay. Even manipulation within the peritoneal cavity under warm salt solution checked gastric peristalsis for three hours.

Fig. 1. Isthmus of duodenum. (Reproduced from Author's paper in *Surg. Gynec. Obst.*, Feb. 1918, with permission of publishers.)

Fingering gently in the air caused greater retardation and after rough handling in the air, no food passed the pylorus for four hours and then emerged slowly.

Riedel describes acute dilatation due to serous infiltration of the stomach wall causing muscular weakness.

Kelling describes a valve-like closure of the cardia which is opened by contraction of muscle fibers extending from the esophagus into the fundus and believes that weakening of these fibers or increase in intragastric pressure which maintains the closure of the cardia, makes it difficult for regurgitation into the esophagus to occur.

He maintains that closure of the cardia and obstruction in the duodenum are both required for dilatation to take place.

The dual lesions undoubtedly favor acute dilatation but, that a double obstruction is not essential is shown by cases with persistent vomiting from the onset.

Both Albrecht and Glénard have described the normal compression of the duodenum between the spine and mesenteric root (the isthmus of the duodenum) and the former demonstrated, upon the cadaver, that traction, downward and backward, upon the mesenteric root converts the constriction into complete obstruction.

Confirming this, Conner's experiments are instructive; with the body of a cadaver in the dorsal position, the small intestines were removed and a cord was attached to the mesenteric root and passed out of the anus and to it weights were attached.

The stomach and duodenum were filled with water through a tube introduced by way of the esophagus and the pressure required to overcome the duodenal compression was estimated by connecting the tube to a mercury manometer.

In several instances a load of 500 gm., the approximate weight of the empty small intestine, caused sufficient obstruction to require a water pressure of 20 to 48 mm. of mercury to overcome it.

In fleshy individuals, Miller found that it was difficult to produce obstruction until the fat had been removed from round the mesenteric root.

From these experiments, it is concluded that prolapse of the small intestine into the pelvis may, under favorable conditions, produce mesenteric compression. It seems obvious, however, that if the prolapse is sufficient to permit the intestines to rest upon the pelvic floor, compression will not occur.

Among predisposing causes are relaxation of the abdominal walls, ptosis of the viscera, a low position of the third duodenal segment bringing it into relation with the prominent lumbar vertebrae, chronic duodenal obstruction and lordosis of the lumbar spine.

It is favored by a collapsed condition of the intestine, from fasting and purgation

before operation, and by prolonged dorsal decubitus.

Primary gastric dilatation due to disturbance of innervation or obstructive kinking at the superior duodenal angle is recognized, but in the majority of instances of dilatation with grave symptoms, mesenteric obstruction will be found.

The terminal branches of the superior mesenteric artery supply the small intestine.

The arterial walls are not so elastic as the tissues that surround them so that prolapse of the organs to which they are distributed transmits pressure through the superior mesenteric artery to that part of the duodenum which is crossed by the mesenteric root.

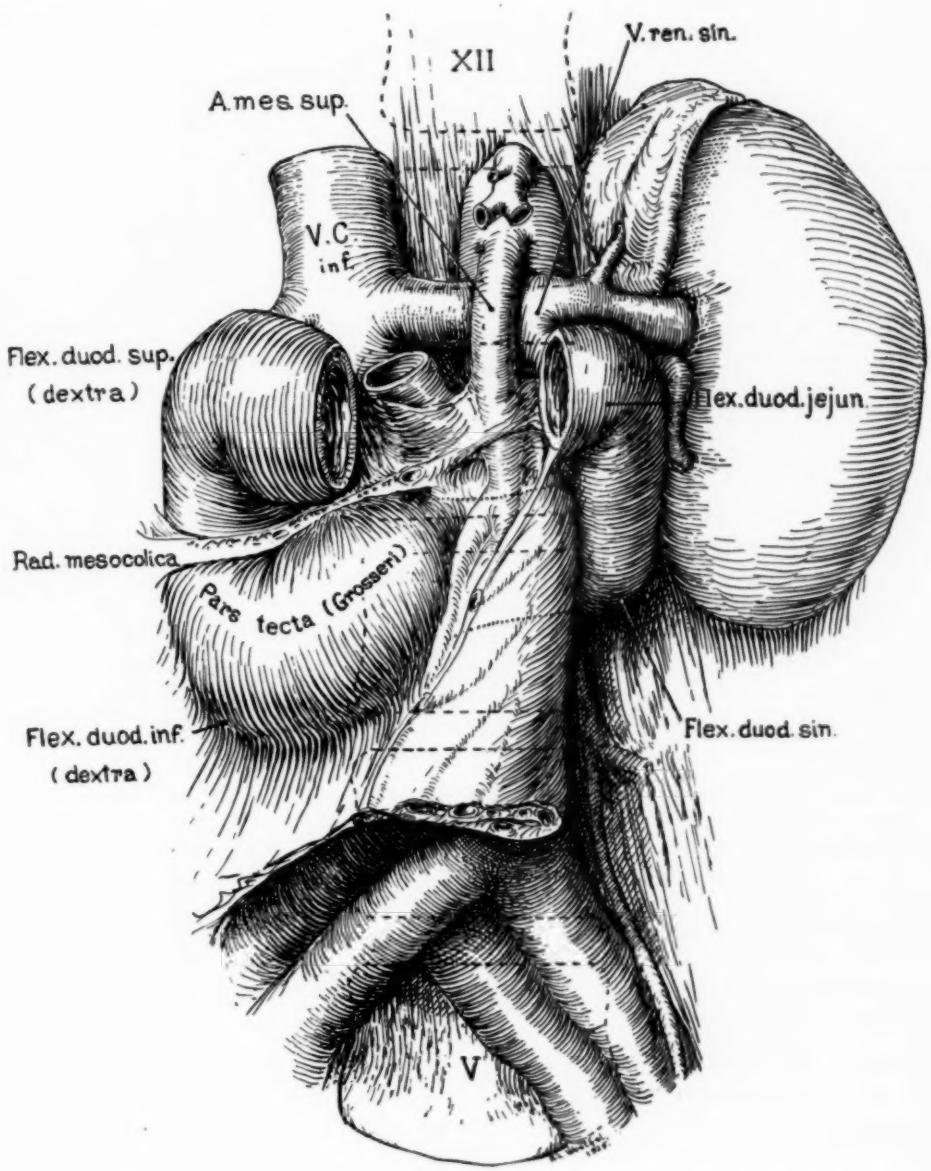

Fig. 2. Relation of duodenum to mesenteric root. (Dissection by Halpert published with permission of Author and of *Johns Hopkins Hosp. Bull.*)

PATHOLOGY

The most obvious pathology is the greatly dilated stomach which may appear to fill the abdomen. Its walls are thin or thickened and edematous. The duodenum

is dilated above the point of obstruction. The essential pathology is the compression of the third duodenal segment between the spine and aorta posteriorly and the mesenteric root anteriorly.

The same changes in the stomach may be produced by kinks at the superior and the duodenojejunal angles and occasionally by compression of the jejunum at the pelvic brim when the small intestines are tightly wedged into the pelvis.

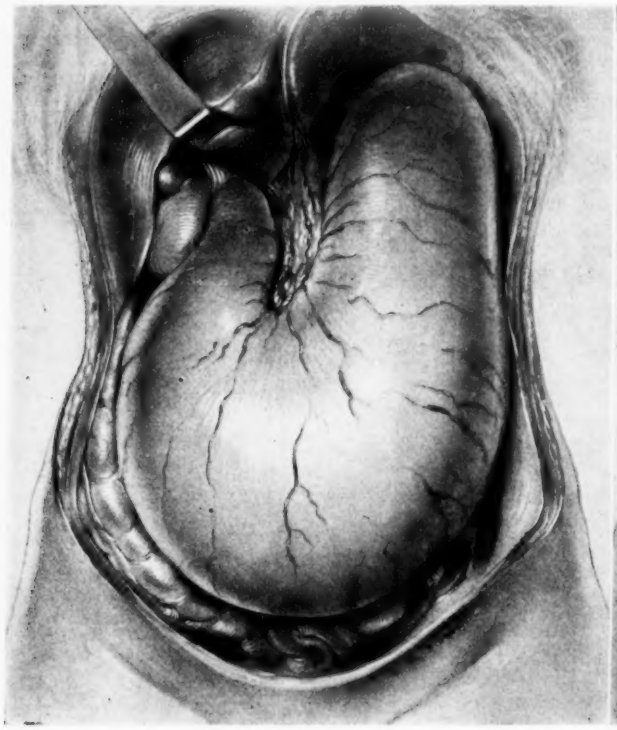

Fig. 3. Dilated stomach due to mesenteric obstruction of duodenum occurring during convalescence from operation for appendicitis.

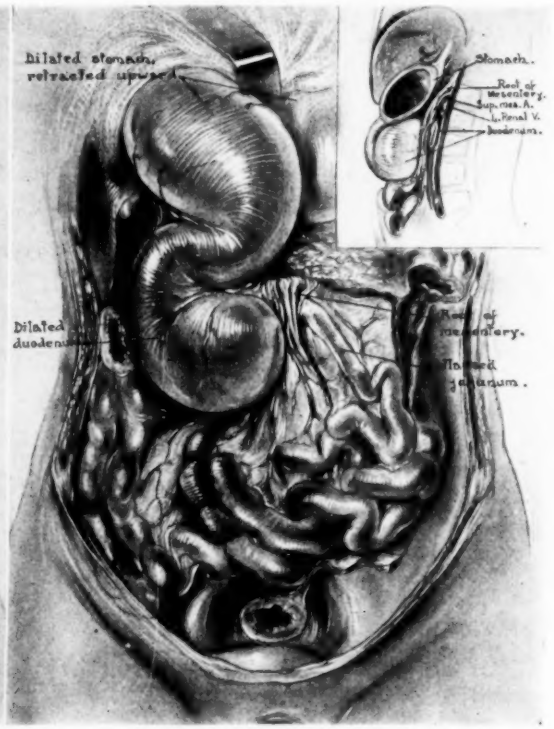

Fig. 4. Same case. Dilated stomach retracted upward showing obstructed duodenum. (Insert added to show mechanism of obstruction.)

SYMPTOMS

General Condition: At first the patient is apathetic and comfortable, the mind is clear, pulse normal or increased in rate and small in volume. Blood pressure is low and temperature is normal or subnormal, unless the condition complicates a febrile state but in the terminal stages the temperature may be high or low.

After a variable period symptoms of collapse occur with clammy skin, anxious expression, delirium or coma.

Vomiting occurs in 90 per cent of the cases, but may be a late manifestation, the stomach gradually dilating until the limit of distension is reached. In its absence the condition more readily escapes detection.

The characteristic vomiting occurs without straining; the fluid comes up in gulps or seems to run out of the mouth. It is an overflow, a "spilling over" of the distended organ and does not empty the stomach so that a stomach tube, introduced after vomiting reveals the presence of a large quantity, often several quarts, of fluid.

The vomitus is thick or thin and varies in color from yellow or green to almost black.

The odor is foul, cadaverous, but not feculent. A thick dark offensive secretion is characteristic of a serious state. Change to a lighter color, thinner consistency and less offensive odor keeps pace with improved conditions.

The fluid contains bile, pancreatic secretions and sometimes blood. Hydrochloric acid is usually absent.

The quantity of fluid aspirated or vomited greatly exceeds the fluids ingested and may collect so rapidly as to completely fill the distended stomach within a few hours.

Urinary changes bear a direct relation to the severity of the toxemia: indican, albumin, granular casts, cylindroids, high specific gravity and scanty output are regularly observed.

The blood changes are important.

With the progressive dehydration, there is an increase of hemoglobin and in the number of red cells.

The blood chemistry, as in other forms of high intestinal obstruction, shows decrease in plasma chlorides, increase in CO_2 carrying capacity of the blood, increase in urea and non-protein nitrogen (alkalosis).

These changes are attributed to loss of hydrochloric acid, dehydration and the absorption of a toxic proteose substance formed in the epithelial layer of the duodenum.

Tetany may develop and bears a direct relation to the alkalosis.

Cyanosis, dyspnea, eructations and hiccough are occasionally observed. Constipation is the rule, but diarrhea has been noted.

Thirst is often intense due to the loss of body fluids.

Pain may be referred to the epigastric or umbilical regions but is not uniformly present and in the writer's experience has been infrequent.

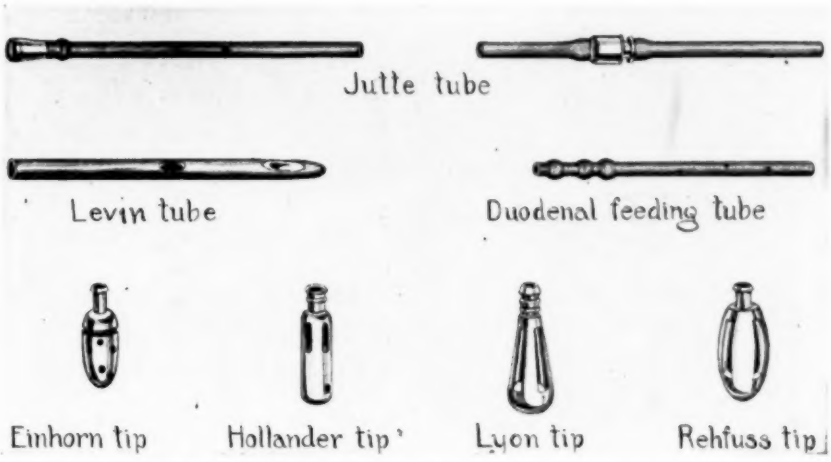

Fig. 5. Types of duodenal tubes in common use.

Those with large tips are adapted to irrigation, bile tract drainage, or aspiration of gastric contents.

Levin tube with tip like catheter particularly adapted to aspiration or lavage by transnasal route and is most useful in treatment of gastro-mesenteric ileus.

Jutte tube adapted to irrigation but is not satisfactory for lavage. It may be passed by transnasal route. Its special advantage is that it can be stiffened by introducing a wire within its lumen and passed like a stomach tube.

Duodenal feeding tube is most satisfactory for tube treatment of ulcer.

PHYSICAL EXAMINATION

The abdomen is usually distended but may collapse after the stomach has been emptied.

Distension first occurs in the epigastrium but later involves the entire abdomen.

Muscular rigidity and visible peristalsis are infrequent but tenderness about the navel or in the epigastrium is usually observed.

DIAGNOSIS

The diagnosis should not present unusual difficulties although the condition is often overlooked. Frequently when one passes the bed of a patient, a brown or black stain (black vomit) will be observed at the angle of the mouth where regurgitated fluid has soiled the skin. This alone should suggest the possibility of gastro-mesenteric ileus or some other variety of high obstruction.

The characteristic "spilling over" of

gastric contents with an enormous residue revealed by the tube, absence of fever, epigastric distension, relieved by lavage

Fig. 6. Technique of gastric lavage with Levin tube. Patient allowed to drink water freely to facilitate passage of tube. Water removed by aspiration.

and the urinary and blood changes, are characteristic.

DIFFERENTIAL DIAGNOSIS

It may be confused with peritonitis, uremia, acidosis and acute dilatation of the stomach of nervous origin.

With peritonitis there is general tenderness, rigidity, leucocytosis and fever which are lacking in this condition. Gastric succussion, the characteristic vomiting, and the relief of distension after emptying the stomach suggest gastro-mesenteric ileus.

With peritonitis, the epigastrium is the last region to become distended, with gastro-mesenteric ileus, the first.

The blood changes will differentiate it from acidosis.

If attention is first directed to the urinary changes, it may be confused with uremia.

It may be differentiated from acute dilatation of the stomach of nervous origin, by the fact that the latter is a relatively benign condition unless secondary duodenal occlusion occurs. It usually develops early, possibly while the patient is on the operating table.

The distension is chiefly gaseous, and the fluid recovered does not at first present the characteristics of ileus.

PROGNOSIS

In 75 per cent of the fatal cases the duration of the illness is less than five days, the range being from a few hours to sixteen days.

The combined statistics of Conner and Laffer, covering 319 cases, yield a mortality of 67.5 per cent.

Doolin gives the following statistics indicating the comparative mortality under different forms of treatment:

Cases	Deaths	Per Cent
31 treated with drugs	29	93
29 treated by operation	21	72
54 treated by lavage	25	50
30 treated by change of posture	2	7

Death is due to dehydration, alkalosis, toxic nephritis, interference with circulation and respiration, and is attributed to the absorption of metabolic toxines formed in the mucosa of the obstructed duodenum.

Early diagnosis and intelligent treatment will greatly lower the mortality.

TREATMENT

Prophylaxis: Before operation avoid strong catharsis and prolonged fasting.

During operation avoid unnecessary exposure and manipulation of the viscera. Examine for chronic duodenal obstruction and prolapsed small intestines.

After operation avoid prolonged dorsal position, keep on right side as much as possible or on abdomen, if not contraindicated.

If the small intestines are in the pelvis at the time of operation, use Trendelenburg position.

Food and fluids should be given in small quantities at first to avoid distension.

With the onset of digestive discomfort, belching, nausea and regurgitation, aspirate the stomach contents.

Many surgeons feel that lavage after operation subjects the patient to severe

strain, and postpone it until the need is imperative.

It is, however, safer to empty the stomach early and to repeat the procedure frequently if there is a tendency for fluid to collect rapidly.

The stomach tube should be of moderate size and velvet finish. The openings should be placed laterally, near the tip, their combined caliber exceeding that of the lumen, the margins smooth and rounded. The tip should be hollow and soft.

If the patient is not accustomed to lavage, a duodenal tube is preferable.

One is selected with an open end (Levin tube) or with a small tip (Jutte tube), and introduced through the nose while the patient drinks water to carry it down.

It causes little discomfort and as the stomach is to be emptied promptly, the quantity of water need not be limited.

The condition established: The indications are to keep the stomach empty, to restore body fluids, relieve mesenteric compression, combat alkalosis and stimulate peristalsis.

To keep the stomach empty: Discontinue food and fluid by mouth.

Even though the patient appears moribund, introduce a stomach or duodenal tube for a distance of 20 in. to insure reaching the greater curvature of the stomach, which may be at the pelvic brim.

Remove the contents by syphonage or aspiration before washing with normal saline solution, measure the water introduced and recovered to avoid increasing the dilatation.

Repeat the procedure often enough to prevent re-accumulation of toxic products, possibly every three or four hours, day and night, until improvement is shown by diminution in the quantity of secretion, lighter color and less offensive odor. The intervals between treatments are then gradually lengthened.

If frequent aspiration is required, it may be desirable to leave the tube in situ and to maintain continuous drainage.

Fluids can be given through the tube and can be held in the stomach, by applying a clamp until it is desired to repeat the drainage.

The best time for introducing food and fluid is immediately after the stomach has been emptied.

To restore body fluids: The importance of early and continual replacement of the fluid lost has been demonstrated in experimental ileus (Maury, McLean, Wilkie, Hartwell and Hoguet).

Normal saline solution is introduced by rectum, intravenously and subcutaneously.

To relieve mesenteric compression: An abdominal binder is applied with a pad above the pubes, the foot of the bed is elevated and the patient is turned upon the abdomen, or in suitable cases, a knee-chest position is assumed, with the abdomen supported by pillows. These measures tend to relieve the downward drag of the distended stomach and prolapsed small intestines and the stomach is more readily evacuated.

A procedure, recommended by Conden, reverses the position of the bed and forces the small intestines upward by filling the pelvis with Ringer's solution, introduced by needle puncture of the abdomen. The addition of glucose prolongs the effect by delaying absorption (Ringer's solution—sodium chloride, 0.7 per cent; potassium chloride 0.03 per cent; calcium chloride 0.02 per cent, 2500 c.c., and glucose solution 500 c.c.).

To combat alkalosis: Sodium chloride is selected because it can be administered freely by all the avenues of absorption and in suitable cases may be supplemented by using dilute hydrochloric acid.

Bicarbonate of soda is contraindicated in all cases with a tendency to alkalosis and should be avoided until the blood chemistry changes have been determined for there is clinical and experimental evidence of its toxic effect.

To stimulate peristalsis: Eserine salicylate is useful but is a circulatory depressant. Pituitrin is somewhat less effective.

Eserine salicylate grain 1/40 hypodermatically and a croton oil enema (croton oil, 2 drops, castor oil, olive oil, glycerine, 2 oz. each) may prove a useful combination.

An enema of 6 per cent salt solution may also be effective. It stimulates peristalsis powerfully, preceded by antiperistalsis (Kelling).

There is little indication for other remedies although atropine, warm compresses, turpentine stoups and strychnine have been recommended.

When fluids are resumed by mouth, advantage may be taken of the fact that weak alcohol solution is more rapidly absorbed than plain water and that carbohydrates leave the stomach more rapidly than fats or proteins.

Operative Treatment: Operative results are not encouraging. The procedures have consisted of gastrotomy, gastrostomy, gastroenerostomy, jejunostomy, and exploratory laparotomy.

The mortality of 72 per cent (Doolin) will deter one from operating when the combination of lavage, change of posture, and the combating of dehydration and alkalosis yield a mortality of about 7 per cent.

SUMMARY

Acute gastro-mesenteric ileus is the cause of death in numerous medical and surgical conditions. The essential pathology is the compression of the lower duodenal segment by the mesenteric root. The clinical manifestations consist of marked dilatation of the stomach, the accumulation of toxic fluids in the stomach, greatly in excess of the fluid ingested, dehydration, toxic nephritis and a tendency toward alkalosis.

The treatment should consist of frequent evacuation of the stomach, postural changes to lessen the compression of the duodenum, and the introduction of large quantities of saline solution to combat dehydration and alkalosis.

The use of alkalies and surgical intervention is contraindicated.

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THE TREATMENT OF CONGENITAL DISLOCATION AT THE HIP-JOINT*

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THE treatment of congenital dislocation at the hip joint was seldom attempted until Paci, in 1888, presented his method of closed reduction. At about the same time the open operation was performed; but, on account of poor surgical technique, there were frequent bad results and the method came into disrepute. The closed reduction was not very satisfactory at first, but with Lorenz's modification of the Paci method better results were obtained and a new stimulus was given to the treatment of this deformity. With the introduction of Hoffa's improved open operation that form of treatment received a number of adherents. The closed method proved to be the most popular; but with an ever increasing demand for better results and a considerable number of failures, not a few investigations have condemned the closed method. Because of these adverse experiences there has recently been a tendency to revert to the open method of reduction which, on account of the perfection of surgical technique, has been freed from many of its dangers. However it behooves us to reserve our final decision until more convincing evidence is presented to show its advantage over the closed treatment. In this report both methods will be considered and data presented which it is hoped may be helpful, when added to the increasing statistics, to aid in determining the indication for one or the other type of treatment.

In 1922 Denuce,[1] of France, published a short article in which he reported that he had performed, without a fatality or immediate complication, 1300 closed reductions for congenital dislocation at the hip-joint. His results show no fractures or separations of the head and no injuries to the epiphysis, nerves, vessels or skin. There were only 12 reluxations, 10 of which were subsequently successfully reduced. This high standard had not been approached before. The majority of reports show anywhere from 50 to 85 per cent of successful results. Careful manipulation and meticulous attention to detail in the post-reduction treatment are responsible for this success.

In writing of his method Denuce points out as the most important thing to observe, the suppression of all force and the avoidance of any trauma of the cartilage, bone or soft parts. If he failed in his first effort he put the patient to bed and applied traction up to 8 kg. on the dislocated side. He never broke down the muscle tissue and if it needed special treatment he massaged it with a movement parallel to the muscle fibers. Thus he differed from most other operators and especially from Lorenz who often uses extreme force in the reduction and even uses the head as a reamer to deepen the acetabulum.

Denuce placed the age limit for a double reduction at eight years and for a single reduction at eleven years. He attempted manipulation in the older children if the individual was not greatly developed and weak muscularly, and then only at the express wish of the parents.

In the after care he carefully carried out the following procedures: At the end of six months the plaster was bivalved. With the patient in half of the shell extension of the knee-joint and rotation were gradually performed. Exercises were given for the gluteus maximus. At the end of about three weeks the leg was brought up to the straight position and the child allowed to sit up. Heat in the form of hot sand bags was

* From the Shriner's Hospital for Crippled Children, San Francisco. Submitted for publication November 28, 1930.

applied to the hips and extremities for an hour at a time. Later salt baths were given in which 1 kg. of salt was added to 10 l. of water, this being sufficient salt in which to float the patient. Heliotherapy to tan the skin and for its secondary effect on the bones was then given. The period of half immobilization lasted from one to four months or until the child had recovered a good part of his mobility, until there was an increase in calcification of the bone and the form of the epiphysis approached the normal. The patient was then allowed to walk a little, the described treatment being carried out all of the time.

FIG. 1. Right hip after reduction. Excellent function. Some flattening of head and changes in neck of femur.

If other operators could approach the standard set by Denuce there would be no need to look further for a method of reduction for congenital dislocation at the hip-joint. Unfortunately there are few who are willing to desist from frequent and forceful attempts to reduce the dislocation, and there are, likewise, few who have the patience to carry out the slow, painstaking program of post-reduction care described by Denuce. It is, therefore, unlikely that many will attain an equally high degree of perfection.

I have always been interested to know what Denuce set as his standard for judging a successful result. After all there is a definite personal element in all conclusions. One might ask how critically he interpreted the results of his cases, how long he kept them under observation after the treatment was completed, how much motion he considered necessary to success, whether there was always a normal gait following reduction, whether the position of the extremities was normal, whether the head of the femur showed changes in later life and whether arthritic changes and manifestations appeared. It is seldom that one sees films made after a supposedly successful reduction which do not show changes, especially in the form of the head and the tendency toward upward migration. It seems strange that in none of the cases described by Denuce did extreme anteversion or antetortion exist to preclude the possibility of a successful reduction. Neither were there any cases of hourglass capsules, shallow acetabulums, marked muscle contractions or contracted cotyloid ligamentus impediment to prevent reduction or cause redislocation. But regardless of the exactness of the report on the finished results one must marvel that anyone could obtain such success in reducing 99.8 per cent of the treated cases using the closed method of correction.

FIG. 2. Three years after reduction for left dislocation. Excellent function. Head of femur higher than normal and acetabulum rather shallow.

A brief review of some of the other reports on this subject may be interesting

for comparison with those submitted by Denuce.

Soutter and Lovett[2] in 1924 reported the

Fig. 3. Result after bilateral open reduction with shelf and bilateral femoral osteotomies. In this patient primary closed reduction was performed but at age of four years luxation took place on both sides. Final result only fairly good. Both femurs are high with changes in head and neck.

results of 277 cases of congenital dislocation at the hip-joint that were treated at the Children's Hospital in Boston between the years of 1912 and 1920. At least two and a half years had elapsed after each reduction before results were taken. Their summing up shows 71 per cent of successful results. In 40 per cent of the 35 per cent that required reoperation, segmentation of the head occurred. There were 2 cases of peroneal paralysis and 3 cases of fracture of the femur.

Farrel, Von Lackum, and Smith[3] reported the results of 366 cases which were treated at the New York Orthopedic Hospital between the years of 1900 and 1920. In only 41 per cent of their cases had the head of the femur remained in the acetabulum with a good functional result. Five per cent could not be reduced at all. These operators believe that anteversion plays an important part in redislocation. Where anteversion was over 50°, only 30 per cent of the results were successful. These men often bring out the point that they often failed to correct anteversion by osteotomy. In only 7 cases did they find perfect anatomical results as determined

Fig. 4. Open reduction with shelf for right dislocation. Opposite hip to be reduced by open operation if good function is obtained on right side.

by comparing the roentgenograms of the normal with those of the operated sides. However, an abnormal condition appearing in the roentgenographic pictures did not indicate necessarily a poor functional result.

Galloway,[4] who is a great advocator of open operation, states that he was driven to the open method of reduction by the distracting uncertainty and frequent failure which attended his former efforts with the manipulative cure. He practices the operative treatment on even the very young and reports excellent results.

De Forest Willard[5] reported in 1926 the results of 26 reductions by the Davis method. These cases had been treated at least a year before the report was made. There were 60 per cent with good results and 30 per cent with instability. Ten per cent were failures. He believes the poor results are caused by too much trauma resulting from manipulation, too early weight-bearing and tardy reduction.

Chatterton and Flagstad[6] in 1925 reported on 182 treated cases with 87 per cent reductions and 75 per cent of good results a gradual higher percentage being obtained in the more recent cases.

Putti[7] reported in 1926 the results of a series of 2500 cases of reduction of both single and bilateral congenital dislocation of the hip-joint. He used the Paci method and obtained success in 90 per cent of the single and 65 per cent of the bilateral cases. Five per cent of the whole number could not be reduced. This operator places as his age limit seven years for the single and four years for the bilateral attempted reduction. Open operations are performed only when the closed method fails or when the age limit has been exceeded. In a recent article Putti advises early reduction, even during the first year. At this early age it is sufficient in many cases to put the legs in forced abduction on a specially devised frame. To judge from the reproductions of the films taken of some of the infants treated by Putti it appears that in certain cases the results were merely subluxations.

Ely[8] in 1925 reported that about 55 per cent of his series of 28 cases were successful. He used the Lorenz method of treatment with open operation if necessary.

In 1921 Ridlon[9] published a paper in which he cited the lessons gained from his personal experience with cases of congenital dislocation at the hip-joint. He stated that after a number of fractures of the femur and general bad results with the Lorenz method he devised a treatment of his own. According to his method, while the thigh is fully flexed an endeavor is made to lift the upper end of the femur, keeping the fingers at the back and the thumbs in front to feel the head as it slips forward into the socket. Over a period of fifteen years his results show an improvement of from 60 per cent of successful reductions in 1905 to 80 per cent in 1920. Ridlon had the opportunity to follow personally a number of cases treated by Lorenz in 1902 and 1903 and reports that many of the supposedly successful reductions proved to be failures. Ridlon reported in his article another interesting fact, namely, that A. H. Ferguson in 1900 turned down a shelf from the side of the ilium to support a dislocated hip. Recently, under the name of the Dickson operation: the same procedure has been recommended for irreducible dislocation of the hip.

Stephens[10] in 1928 reviewed the results of 222 cases treated at the Hospital for the Ruptured and Crippled in New York. He found that the anatomical and functional cures were obtained in only 15 per cent of the cases treated.

It is plain then, to judge from the varying results obtained by these operators, that there is a strong personal element involved in the interpretation of the meaning of a successful reduction of congenital dislocation at the hip-joint. The standard by which a finished reduction is judged, depends, to a great extent, upon the degree of perfection which is considered necessary to success and upon the different emphasis placed, by each operator, upon the various factors in summing up the results. The most important of these factors are the range of motion and the variations in gait, the resultant manifestations in later life and the roentgenographic study of the preoperative and postoperative pictures.

For example, each operator may have a different standard by which he judges a successful functional result; one may place utmost importance in the variations in gait while another may overlook this in favor of the resultant range of motion. One may draw his conclusions shortly after correction while another may keep in touch with the patients for several years after operation and take later changes into consideration in tabulating his findings. Likewise, in studying the roentgenograms there are many chances for variation especially in the interpretation of the pictures themselves. Shortly after reduction there may be an apparently perfect result but with the lapse of time changes may occur in the shape of the head and acetabulum with subsequent reluxation. Thus we realize that there are many interesting factors and varying combinations of factors which influence the statistics in each group of cases.

But in spite of the personal element which is largely responsible for the discrepancy in the findings, it is safe to say that certain methods of reduction offer greater possibilities for success than others. It is noted that the methods of Denuce and Davis, because of the better results obtained by them, are gradually replacing the Paci procedure which was modified and practiced by Lorenz. Following is a résumé of the Denuce and Davis operations, of the methods which are used to treat various complications following reduction and of the open operation which is used to correct cases of irreducible dislocations and any other cases which do not yield successfully to less radical forms of treatment.

The Denuce Method: The anesthetized patient is placed on his back, after which the thigh is flexed at the hip-joint while the knee is in flexion. The thigh is gradually abducted, this being made possible by gently massaging the abductors. After full abduction is obtained the knee is then carried across the body until it points in the direction of the opposite axilla. Downward pressure is then made on the knee and by a movement of circumduction the extremity is brought down while at the same time the fingers placed under the head of the femur make upward pressure in the direction of the acetabulum into which the head is directed. If the reduction is successful the leg is maintained in the position of 90° abduction and 90° flexion by a single or double plaster hip spica which extends to the ankles. The time for the change of plaster depends upon the stability of the hip immediately after reduction. If there is a tendency toward easy redislocation the hip is maintained in the primary position for a longer period to allow for greater adaptive changes between the head and the acetabulum. The usual time for changing the plaster is at the end of the third month and again about every six or eight weeks. Particular attention is exerted to secure internal rotation as the leg is brought down. At the end of about nine months the extremity should be in the normal extended position, at which time physiotherapy and exercises are put into effect. As soon as the muscles regain their tone the patient begins to walk with support which is gradually abandoned.

Davis Method: The patient is placed face down on the table. The extremity is flexed at the knee and then brought up beside the chest. The operator holds the knee with one hand and forces it slowly up from the table while at the same time, with a series of pump-handle motions, he brings the thigh away from the body. While executing this maneuver he creates, with the other hand, strong downward pressure on the great trochanter to force the head forward into the acetabulum. Following the reduction the usual post-reduction treatment is followed.

In some cases the head of the femur will remain in the acetabulum only when the limb is internally rotated and will redislocate as the neutral position is approached. In this event, whether due to anteversion or antetorsion, it is necessary to perform an osteotomy of the femur. The lower fragment is externally rotated to give an internal thrust of the head into the acetabulum as the leg assumes the neutral position. The Sherman method of operation may be used. In this case a long nail or pin is driven through the great trochanter into the neck, a considerable portion of the pin being allowed to project beyond the skin. A subtrochanteric osteotomy is then performed and as the pin holds the upper fragment the lower is rotated to the desired degree. The new relation of the fragments is maintained by incorporating the projecting portion of the pin in the plaster spica. Hibbs performs an osteotomy above the condyles of the femur and rotates the distal fragments outward.

In other cases a fixed external and flexion deformity may persist after reduction. This condition is treated by a modified Soutter fasciotomy and an osteotomy with internal rotation of the lower fragment.

After an apparently successful reduction the head may gradually become displaced

out of the acetabulum. It has been found that an open operation and the insertion of a shelf at the margin of the acetabulum will insure a very good result. In case ankylosis occurs after reduction an arthroplasty may be performed at the end of the growing period.

If it is found impossible to reduce a dislocation by the closed method open operation is performed after a preliminary stretching of the leg muscles by traction. The capsule is exposed by a Smith-Petersen incision, is opened and the acetabulum is located. The head of the femur is then reduced into the acetabulum, a bone skid being used in difficult cases. The capsule is reefed and closed. If the acetabulum is shallow a shelf is made at its margin. It is really advisable to make a shelf in all cases to prevent subsequent displacements.

Primary open operation is indicated in older children where the closed method would result in a great amount of trauma. If, in an open operation, it is found impossible to place the head into the acetabulum a shelf can be built above the head after it is pulled down as far as possible.

Allison[11] has reduced some very resistant cases by first freeing the upper end of the femur and at the same time performing an osteotomy of the lesser trochanter. Skeletal traction is applied after which the head is reduced by a second open operation.

Swett[12] reported the results of an operation in which he performed a transverse osteotomy of the upper end of the femur, after which he severed the muscle attachments to the trochanter and reduced the dislocated head into the acetabulum.

Grove[13] succeeded in reducing a difficult dislocation after the resection of about 2 in. from the shaft of the femur.

Lorenz[14] recommends the bifurcation operation in which an oblique subtrochanteric osteotomy is performed and the upper end of the lower fragment is projected into the acetabulum.

The following report is a summary of the results of 50 cases of congenital dislocation at the hip-joint which were treated at the Shriner's Hospital for Crippled Children in San Francisco. The majority of these cases were kept under observation for from three to five years following treatment:

There were 31 (62 per cent) in which reduction was obtained by using the closed method of treatment. In 12 of these it was necessary to perform a secondary operation because of a persistent deformity or a tendency to subluxation. In practically every case in which an open operation was performed the margin of the acetabulum was reinforced by a shelf thrown down from the side of the ilium.

Four cases (8 per cent) which were irreducible by the closed method were successfully treated by open operation.

In 5 cases (10 per cent) primary open operation was performed because this procedure indicated better results than the closed method.

In 2 cases (4 per cent) the head of the femur was not placed in the acetabulum but was pulled down as far as possible and held in place by a shelf of bone turned out from the ilium.

In 8 cases (16 per cent), in which reduction by the closed method failed, no further treatment was rendered.

It is very difficult to tabulate accurately the final results. The rather elastic classification in which the terms excellent, good, fair or poor, while subject to criticism, is about as useful as any for calculating comparative results.

In the group of cases studied there were:

Excellent: 6, or 12 per cent

Good: 29, or 58 per cent

Fair: 7, or 14 per cent

Poor or Failures: 8, or 16 per cent.

It is interesting to note that only 10 of the 50 cases were under four years of age and a large percentage were bilateral. This relatively high age limit naturally adds to the difficulty of the reduction and lessens the chances of obtaining a good result. In the 8 cases under the heading of *poor, or failures,* the ages of the children treated were twelve, ten, nine, nine, eight,

eight, five and five years. This is in accord with the results of other operators, which indicates that the treatment of older patients is less satisfactory, especially if the dislocation is bilateral.

Discussion: Whether the open or the closed method of treatment in cases of congenital dislocation at the hip joint is the more satisfactory is a question which remains unanswered. The results obtained by Denuce and Putti, who have had more experience than most other operators, indicate that the closed treatment is, at the very least, successful. But not until someone has had an equal opportunity to accomplish a large series of primary open operations can a comparison of the results be made. Unless results can be obtained which prove that the primary open method is more successful than the closed, primary open operation in all cases is not advisable. In the hands of an experienced and skillful operator with good technique the open operation is easily and safely performed. On the other hand the closed method is, without doubt, easy, safe and satisfactory. In most patients up to five years of age closed reductions by the experienced operator can be performed in a very short time with prospects of a good result. Therefore, until primary open operation can be proved more successful, the present procedure of attempted closed reduction, with open operation in cases of failure, is indicated.

Judging from my own experience I feel that in young children, up to six years, whether the dislocation is single or double, the closed method of Denuce is satisfactory. If the case can be obtained before the age of three years the reductions should be near 100 per cent. In older children or in young patients where there is abnormal muscle development and other signs of resistance to reduction primary open operation offers the best choice of successful cure.

In all open operations I find it is advisable to reinforce the upper rim of the acetabulum with a shelf of bone. This procedure takes very little longer, can be accomplished during the same operation as the reduction and renders added security against redislocation.

In treating dislocations which are very resistant to reduction even by open operation it may be advisable to utilize some of the enumerated procedures that have been found helpful in this class of difficult cases.

Conclusion: Until there are further definite statistics in favor of primary open operation it is advisable, up to six years of age, to attempt a closed reduction before resorting to open operation. In older children, or in cases where there is evidence of abnormal resistance, open operation has the best chance of a cure. If open operation is performed a shelf can be inserted at the time to insure retention of the head of the femur in the acetabulum.

Early recognition and early treatment will do more to increase successful results than any other measure.

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[For Remainder of References see p. 243.]

FRACTURE OF EXTERNAL SESAMOID BONE AT THE FIRST METATARSOPHALANGEAL JOINT

WITH REPORT OF A CASE*

MARCUS H. HOBART, M.D., F.A.C.S.

CHICAGO, ILL.

A. R. male, forty-one, colored, laborer, entered Evanston Hospital clinic on February 28, 1930, because of a left foot injured when a wheelbarrow full of planks turned over, the planks striking the top of the foot forcibly. Examination showed some swelling on the dorsum of the foot, with tenderness elicited over the plantar surface on the outer, fibular, side of the head of the first metatarsal bone. The history and findings were typical for fracture sesamoid bone, and *x*-ray showed an oblique division with the following report.

FIG. 1.

FIG. 2.

Evanston Hospital, 32113, or Cook County Hospital, 10204, left foot.

"There is an os tibiale externum, commonly known as the sesamoid in the tendon of the tibialis posticus, which is frequently found. This sesamoid bone is often found, and has no significance. Under the great toe are two sesamoids, the external of which seems to be divided. The sesamoids are often divided, and when so, are sometimes mistaken for fractures. Of course it is possible for a fracture of the sesamoid to occur, but so often we find it divided, that it is difficult to say whether or not a fracture has occurred. The attending physician will be guided in this case largely by the physical findings at the time of the examination."

There is evidence of osteoarthritis involving the first metatarso-phalangeal joint"—(James T. Case) (Fig. 1).

According to our article published in

* Submitted for publication Dec. 1, 1930.

April, 1929,[1] on sesamoid fractures, few fractures of the external sesamoid bone of the great toe have been reported in the literature, and no cases of congenital division of that bone. Since then Dr. James T. Case has called our attention to 3 cases of congenital division with roentgenograms reported in the German literature.[2,3] As the congenital divisions are usually smooth and transverse or longitudinal, and this division rather oblique and irregular, a diagnosis of fracture was made, and the foot and ankle incorporated in a cast in the proper position. The patient was watched for four weeks, but he continued to complain of pain whenever slight pressure was made on the plantar region over the fibular sesamoid bone. We decided therefore to remove the fractured bone, and did so at Cook County Hospital, on April 3, 1930. The bone removed was split obliquely. As early as ten days after the operation there was no pain or pressure in the same region, which helped to confirm clinically, the diagnosis of fracture. The removal of the bone gave us the opportunity to confirm the diagnosis again through the pathologic laboratory, which Dr. William Brandes, of Evanston Hospital, did, making sections, reporting as follows:

Sections show dense fibrous tissue and irregular spicules of bone. Several places appear as though there is a gradual transition from dense fibrous tissue to bone. The cells, along the margins of the spicules, arrange themselves in a layer parallel to bone spicules. Between the bony spicules, as in the crevices, there is a less dense network of fibrous tissue. Diagnosis: Dense fibrous tissue showing transition to bone (Fig. 2).

The postoperative cast was removed April 28, 1930, and the patient went back to work, cured, May 5, 1930.

Summary: 1. Although rare, 3 cases of congenital division of the fibular (outer) sesamoid bone of the great toe have been reported in the German literature.

2. Another fracture, also rare, of the fibular sesamoid bone is reported, and the diagnosis of fracture confirmed by: (a) clinical history; (b) roentgenologic findings; (c) operative findings and result; (d) pathologic laboratory examination of the bone histologically.

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[2] Marion, D. *Zeit. f. Chir.*, vol. 102.

[3] Stumme. *Fortschr. a. d. Geb. d. Rontgenstrahlen*, vol. 13.

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*Continued from p. 241.

BUTTON-HOLE RUPTURE OF THE EXTENSOR TENDON OF THE FINGER*

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THE usual injury to the extensor tendon of the fingers is that commonly known as "baseball finger." This

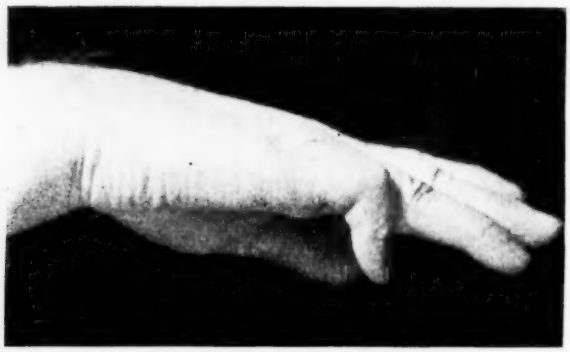

FIG. 1. Button-hole extensor tendon.

injury is due to a tearing of the extensor tendon at its insertion into the base of the first phalanx. Another less common and less easily recognized injury to the extensor tendon is that which has been described as a "button-hole" tearing of the extensor tendon. Its site of occurrence, and the symptoms by which it is manifested are sufficiently characteristic to warrant the report of the following case:

M. C. male, aged seventy, was seen on November 5, 1930, complaining of inability to extend the second phalanx of the fifth right finger. The patient stated that two weeks previously he had accidently struck the dorsum of his finger with the hand partly closed. Though he complained of some pain, he was still able to extend the fifth finger completely. Several days later, and then about one week later the patient again struck his finger at the level of the first interphalangeal joint. It was after this that he first noticed the inability to completely extend the finger at the first interphalangeal joint.

There was complete normal power of flexion of all the fingers, though a peculiar crepitus could be felt over the first interphalangeal joint, when this joint was flexed. Passively, each of the phalanges could be completely extended, but actively the patient could not extend the second phalanx upon the first. The *x*-ray showed no evidence of any pathological process in the joint. On attempting to extend the finger from the position of full flexion, the first phalanx extended, the terminal phalanx became hyperextended but the second phalanx remained flexed (Fig. 1). A diagnosis of partial longitudinal rupture or button-hole tearing of the tendon was made and operation undertaken.

At operation through an L-shaped incision the expansion of the extensor tendon over the first phalanx as well as over the second was found perfectly normal. However, beginning slightly above the first interphalangeal joint, and extending to slightly below it there was a definite oval separation of the extensor expanse. Voluntary flexion of the finger upon the operating table demonstrated the lateral gliding of both halves of the extensor tendon and the rising between them of the distal end of the first phalanx. The edges of this button-hole in the extensor expanse were excised and both halves were approximated with interrupted mattress stitches of silk. The joint was not opened. Immediately thereafter while still on the operating table the patient demonstrated to his and our own satisfaction complete restoration of power of extension at the first interphalangeal joint. The skin was closed and the finger dressed in extension on a tongue depressor splint. Convalescence was entirely uneventful, and motion was begun at the end of the fourth week. At the end of twelve weeks, however, the result was not considered entirely satisfactory. Though the patient has not the disability for which he was originally operated and is able to extend the finger to about 135°, there has apparently been some relaxation of the suture-line, with consequent impairment of complete extension.

As in the case of "baseball finger," the diagnosis in these cases is to be made almost on the history and inspection alone.

* From the Hospital for Joint Diseases. Submitted for publication January 14, 1931.

The deformity, flexion of the second phalanx with ability to actively extend the proximal and distal phalanges in the absence of any bone block or interference with flexion, is characteristic and indeed pathognomonic of button-hole tearing of the extensor tendon or rather of partial rupture involving the central portion of the extensor expanse. The explanation of this phenomenon is readily at hand on recollecting the anatomy of the extensor expanse which Gray describes in the following words:

> Opposite the metacarpophalangeal articulation each tendon is bound by fasciculi to the collateral ligaments and serves as the dorsal ligament of this joint; after having crossed the joint it spreads out into a broad aponeurosis, which covers the dorsal surface of the first phalanx and is reinforced, in this situation, by the tendons of the interossei and lumbricales. Opposite the first interphalangeal joint this aponeurosis divides into three slips; an intermediate and two collateral; the former is inserted into the base of the second phalanx; and the two collaterals, which are continued onward along the sides of the second phalanx, unite by their contiguous margins, and are inserted into the dorsal surface of the last phalanx.

With the finger flexed, the central portion of this expanse is uppermost and is consequently most liable to injury when struck against the prominent edge of the head of the first phalanx. As the flexion is continued the head of the first phalanx projects upward between the uninjured lateral portions of the tendon which are displaced to the sides of the first and second phalanges with a slight crepitating sound. Now, when attempts are made to extend the finger, these lateral portions, in the very act of extending the distal phalanx, grip the sides of the interphalangeal joint below its axis of motion like guy ropes and present normal extension. When the finger is relaxed, and the vise-like action of the lateral expanses obviated, no difficulty is experienced in passively effecting complete extension of the finger at all its joints.

On this basis, the indication for therapy is very concise and unequivocal. The rent in the tendon must be sutured. No hope for even partial recovery can be expected from conservative treatment. As the case herewith reported demonstrates, the prognosis must be guarded even if the immediate operative result appears perfect. Doubtless the poor reparative faculties determined by the age of this patient must have played some rôle in the incomplete result obtained. On the other hand, the normally poor blood supply to aponeuroses and tendons generally must be given some consideration in our prognostications.

OSTEOMYELITIS OF GONOCOCCUS ORIGIN IN AN INFANT

REPORT OF A CASE*

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A CASE of osteomyelitis of gonococcus origin is of sufficient rarity to warrant reporting. Such a case, in an infant, is a still greater rarity. The infant in question was seen by me while acting as voluntary assistant in the out-patient-department of the Hospital for the Ruptured and Crippled, on February 11, 1930.

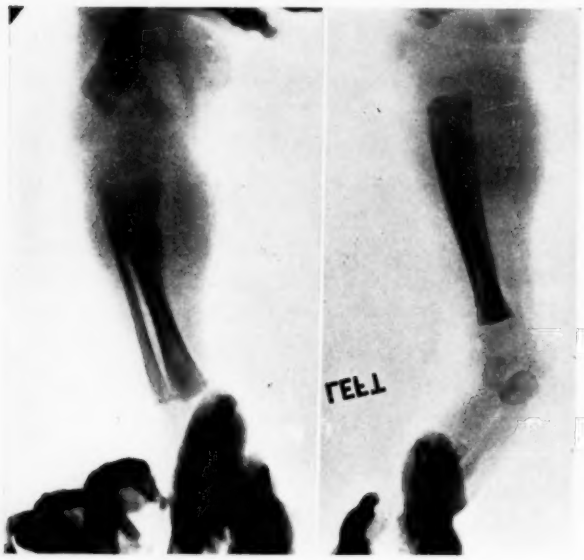

FIG. 1.

The history of the case was as follows: At the age of two weeks the infant became irritable and was noticed to scream with pain whenever the left leg was touched. A swelling appeared on the upper third of the leg which gradually increased in size. Various home remedies were applied, but the swelling continued to increase in size, and the infant was more restless with pain. At no time was a record of the temperature taken. The child continued to nurse well and gained in weight. It was a normal, full-term delivery, having two sisters and one brother alive and well. The father and mother denied having had gonorrhea, by name and symptoms.

When the child was seen at the clinic the following conditions were found: A well nourished infant of four weeks, crying lustily. The general examination was completely negative. The umbilicus appeared normal. The local condition presented a fusiform swelling, surrounding the upper third of the left leg, which was red, dense and extremely sensitive to the slightest pressure. It was 3.5 cm. in width.

FIG. 2.

An *x*-ray taken the same day was reported by Dr. R. W. Lewis (Fig. 1). Anteroposterior and lateral views of the left leg show periosteal new bone being formed about the shaft of the tibia in its middle third and the lower part of the upper third. There is noted an indefinite area of rarefaction in the metaphysis at the upper extremity of the tibia. There is very marked swelling of the overlying soft tissues especially anteriorly. The upper tibial epiphysis has that annular appearance sometimes found in scurvy, but the epiphyseal line and metaphysis give no indication of scurvy.

* Submitted for publication December 4, 1930.

A question of scurvy was raised in this case. However the extreme infancy of the patient militated against this diagnosis. The child was again brought to the clinic two days later. The firm mass had become fluctuant. The temperature had risen to 100.5°F. An aspirating needle was inserted into the mass and 5 c.c. of thick greenish yellow pus, having a somewhat fecal odor were withdrawn. The mass was then incised and drained through two parallel incisions. About 10 c.c. of pus were evacuated. An iodoform drain was then inserted between the two incisions. The progress from then on followed an uneventful course to complete recovery, the drainage ceasing at the end of one week and both incisions healing over rapidly, when the drain was removed.

The pus had been sent to the pathological laboratory for routine examination and the report given by Dr. J. MacWhorter was as follows: Direct smear of pus showed many pus cells, gram negative diplococci intracellular and extracellular. Culture showed no growth.

Since we believed that there was a possible error in the specimen reported, an attempt was made to obtain another specimen of pus from the now healed over wound. Fortunately about 2 c.c. of pus were obtained when a hemostat was inserted into one of the scars. The pus was similar in character to the original.

The report on this pus read: Direct smear shows many pus cells, few gram negative diplococci intracellular and extracellular. Culture showed no growth. The diplococci appeared to be gonococci in morphology and reaction to gram stain and in their repeated refusal to grow on agar-agar or in broth.

Subsequent *x*-ray examinations taken on February 26, 1930 and March 17, 1930 respectively showed:

Fig. 2. Anteroposterior and lateral views of the left leg show the extreme periosteitis noted in the previous film and also an area of erosion of the upper end of the tibial diaphysis. This latter point was probably the original focus of the osteomyelitis, the diagnosis of which was established by the incision and drainage.

Fig. 3. Views of the left upper tibia show much more clear bone detail with less haziness and with smoother bony outlines. The appearance suggests the healing of the inflammatory process. The upper tibial epiphysis has the annular appearance frequently noted in old scurvy and hard to explain at the age of this child.

Fig. 3.

Because we were curious to ascertain the origin of the infecting organism, smears were made of the infant's prepuce and urethra, also vaginal and cervical smears of his mother, and vaginal smears of his two sisters. All of these were reported negative for the gonococcus.

A search of the literature for a report of a similar case of osteomyelitis resulted in failure. H. E. Bardenwerper[1] reports a case of gonorrheal osteomyelitis in an adult, which is apparently secondary to a gonorrheal arthritis.

Speculation as to the mode of infection and portal of entry in the case of the infant leaves one baffled. Obviously there must have been a blood stream invasion which localized in the tibia. The most likely portal of entry must have been through the umbilical cord. However, there was no history of any abnormality in its course in sloughing off. The appearance of the umbilicus at the time of examination was normal. It is possible that the midwife who delivered the child may have been the source of infection. A vaginal smear on her could not be obtained.

[1] *J. A. M. A.*, 94: 1230, 1930.

DISPLACEMENT OF FEMALE GENITAL ORGANS AND THEIR REPAIR*

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NEW YORK CITY

DISPLACEMENT of the female genital organs is not always a local condition but frequently is the end-result of a generalized inferiority of tissue resistance. For many women the trauma of the first and subsequent births leads to serious ill effects, and it is especially disastrous if it is connected with a more or less severe tearing of the supporting, muscular and fascial elements.

Etiologic Factors: Enteroptosis, infantilismus, hypoplasia of the muscular elements, and asthenia as interpreted by Stiller, are all etiologic factors contributing to a constitutional deficiency. In a large series of cases, Sellheim found hypoplastic vestiges of the vagina in one-ninth of all the women examined. Congenital retrodisplacement depends upon general visceroptosis, which, in connection with later parturition involving perhaps a perineal laceration, renders the uterus susceptible to prolapse. Descensus, or prolapse of the uterus is invariably preceded by retroversion, but every retroverted uterus does not necessarily fall. Pregnancies and postpartum conditions are factors predisposing to the relaxation of tissues, particularly of the upper segment of the cervix. Naturally, muscular insufficiency will be more pronounced when the puerperal retroverted uterus, with its broad surface, is exposed to abdominal pressure because the pelvic floor has been relaxed. On the other hand, to quote Sturmdorf, "A uterus congenitally retroposed before impregnation will resume its retroposition after delivery, whether the pelvic floor is lacerated or not."

Types of Displacement: In a consideration of the constitutional origin of displacement, four groups may be differentiated, viz., (1) virgines and nulliparae with developmental disturbances, spina bifida, varicosity and obesity of the hypophyseal type; (2) parae with occasional developmental inferiority, spina bifida occulta; (3) parae in whom symptoms of prolapse develop long after parturition as in preclimax and climax, with lessened tissue resistance of endocrine origin; and (4) post-climacteric prolapse.

Anatomical Basis: Repair with expectancy of a permanent functional result can be accomplished only through a thorough understanding of the anatomical principles underlying the condition. Intra-abdominal pressure must be borne by the muscles and ligaments which constitute a physiologic and dynamic system. In the symptomatology of prolapse the main structures involved are the bladder, the uterus and its appendages, and the pelvic floor. The bladder is suspended from the anterior abdominal wall by the medial and lateral false ligaments, which are in fact only duplications of peritoneum replacing embryonic structures. Support is provided by the uteropelvic fascial plane connecting the lower surface of the pubic bones with the supracervical portion of the uterus. Muscle elements and fascial fibers diverge to both sides of the uterus, thus strengthening the lower portion of the joined broad ligaments. This part, because of its importance in supporting the uterus, is also called the cardinal ligament or, after its discoverer, Mackenrodt's ligament. The other chief means of supporting the uterine body besides the vaginal attachments are the sacrouterine ligaments, which are flat fibromuscular bands extending bilaterally from the upper part of the cervix to the sides of the sacrum at the level of the lower border of the sacroiliac articulation. At the one end these muscular elements are connected with the muscles of the uterus, and at the other end, with those of the rectum (Jackson). The anterior part of the uterine body is attached through the vesicouterine folds, or the peritoneal reflection with the anterior abdominal wall. Corresponding with these folds are the

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rectovaginal folds on the posterior surface, which are reflected from the rectum to the posterior fornix vaginae. Thus the rectovesical fascia and the levator muscles form a twofold sling. This deflects the uterus in such a manner that the body is forced forward and the cervix is pulled backward.

During labor the cervical attachment of the anterior vaginal wall suffers most often, due to tears and overstretching, thus forming in front of the cervix a portion with considerable less resistance, through which the bladder eventually sinks downward (Kelly). On the other hand, the continuous pressure on the descended bladder stretches the anterior vaginal wall and cervix with consequent descensus of the uterus, and associated retrodisplacement. The anterior part of the rectum takes part in the downward movement and a rectocele is produced. The introitus vaginae gapes, and the non-supported vaginal walls exert an undue pull on the cervix resulting in a supravaginal elongation of the cervix.

Operative Procedures: Numerous operations have been devised to relieve these conditions of the female genital organs. To be useful they must promise permanency and not exclude later parturition. Those are commendable which tend to improve the uteropubic fascial support by means of raising its cervical attachment above the original pivotal point, thereby shortening the base of the broad ligaments. This procedure lifts up the body of the uterus and forces the cervix backward. This correction alone, however, leaves a possibility of recurrence following the trauma of subsequent deliveries. The uterine body should be kept in an anteroflexed position but without undue fixation. With this aim in view, Polano devised an operation by which uterine attachment was accomplished by strips from the rectus fascia sutured to the anterior surface of the uterine body. It was found that at later pregnancies the sutured part became elongated and cord-like. Schubert improved on his method by attaching fascial strips to the spoterior surface of the uterine body. He used free transplants of the ileotibial tract and subsequently prepared strips of the pericard of beef. The foreign strips did not take well in the process of healing.

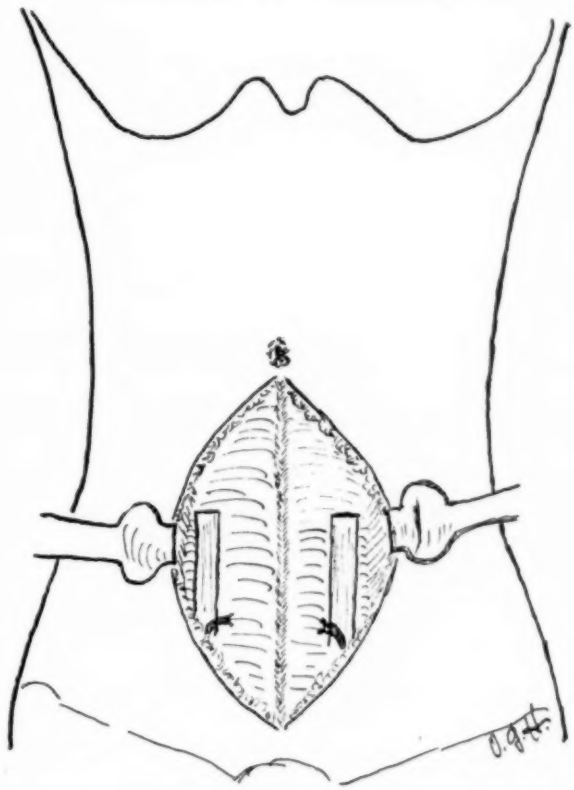

Fig. 1. Fascial strips outlined. Lower end remains attached and is reinforced with catgut stitch to muscle.

The following procedure proved to be satisfactory in 14 cases of the author's. I venture to suggest its use inasmuch as at reexamination one and two years later even after subsequent pregnancy, the uterus remained in the reconstructed position.

The operation can be divided into four steps viz.,

1. Median low laparotomy.
2. Dissection of a strip of about 12 cm. long from the rectus fascia on both sides.
3. Placement of the uterovesical pivotal sutures.
4. Attachment of the fascial strips to the posterior surface of the uterus.

Technique: 1. An incision is made in the midline between the umbilicus and the symphysis. The skin being well retracted, on both sides the rectus fascia is stripped clean to expose the outer contour of the muscle. The rectus sheet, which is a part

of the fascia of the external oblique muscle, is strongest near the outer edge of the straight muscle and therefore this portion

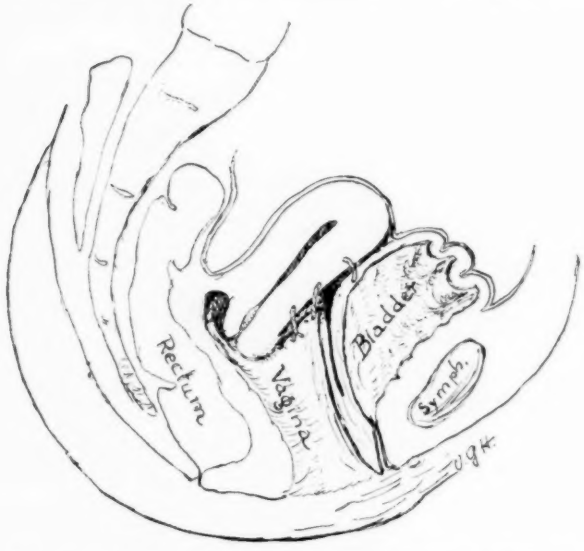

Fig. 2. Catgut stitches fix relaxed vaginal wall and bladder to uterine body. (After Kelly.)

should be utilized. A quadrangular flap 12 by 2 cm. is dissected. The lower pole of this strip is at the level of the internal os of the inguinal canal and remains attached. The flap is turned over to one side and is covered with a moist pad. The rectus sheet is fastened with running catgut suture (Fig. 1).

2. At this point, after opening the abdomen I partly follow Kelly's technique, namely, elevating the bladder by means of two Allis' clamps, thereby putting the anterior vaginal wall on the stretch. The uterovesical reflection of the peritoneum is incised and the bladder pushed back by gauze dissection. The uterus is clamped above the internal os, and two sutures are placed in the muscle and the anterior vaginal wall, which lifts up the relaxed wall and supports the bladder. For this important suture, forty day chromic catgut No. 2 is used. Another suture attaches the bladder fundus at a higher point on the uterus (Fig. 2).

3. Before closure, the free end of the fascial strip is caught with a slender uterine packing forceps and carried through the abdominal wall at the internal os of the inguinal canal. The forceps is pushed forward between the layers of the broad ligament emerging at the posterior surface of the uterus, below and near the tubouterine junction. The end of the strip is

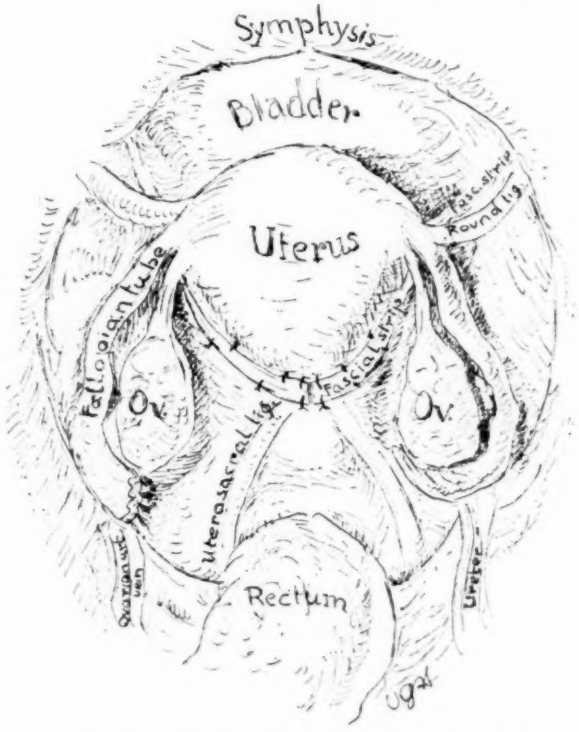

Fig. 3. As viewed from above. Fascial strips sewn on posterior surface of uterus with a few catgut stitches.

grasped, and the forceps is withdrawn. The same procedure is carried out on the other side. Both fascial ends are now pulled down to the uterosacral ligaments, and there joined to the uterus with a few chromic gut sutures. The free section of fascia is covered with peritoneum to avoid adhesions (Fig. 3).

This procedure lifts up the uterus, at the same time leaving it flexible, and free to grow at later pregnancy.

SUMMARY

The operative technique here described is suggested for prolapse and retroversion of the uterus, with due consideration for the dynamic and physiologic system by which the uterus is fixed in its normal position. Recurrences to the former pathological condition are not apt to take place because there are no impediments to pregnancy. Another advantage is that the method can be used in any stage of prolapse.

[For Remainder of References see p. 262.]

STRICTURE OF THE FEMALE URETHRA*

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MY interest in this subject was aroused ten years ago by a case I saw diagnosed as a pus tube instead of as a distended bladder, due to a stricture of the urethra, and this diagnosis was made in spite of the fact that in each of the departments of the dispensary the patient attended for months, her chief complaint was difficulty in voiding.

The purpose of this paper is:

1. To present the 4 cases I have examined, treated and followed since they came under observation, and to review the 169 articles analyzed, together with the discussion of this subject in the various Systems of Surgery, Gynecology, Obstetrics and Urology.

2. To analyze the etiological factors of stricture, and to show that gonorrhea is the most common cause, and that carcinoma is a more frequent cause than is generally considered.

3. To urge that no case should be reported as a congenital stricture, unless it fulfills Young's requirements.

4. To stress the fact that no examination of the female pelvis is complete without a urethral examination.

5. To urge a complete study of these cases by cystoscopy, functional tests, and *x*-ray in order to determine the pathological changes, if any, that follow.

Barthelmey, in 1550, reported the first case of stricture of the female urethra, a congenital type, in which the urethra was completely closed, and the urine passed through the umbilicus. Lisfrance in 1824 and Civiale in 1850, brought this subject more forcibly to the attention of the medical profession. The most careful work has been contributed by Herman, who reported 23 cases in 1886; Hamon in 1901; Vilfroy in 1911; Wynne, 40 cases in 1922; Pugh, 68 cases in 1926; and Gorowitz, 17 cases just recently.

For the completeness of this paper, I would like to present briefly the anatomy of the female urethra. It is 3.5 cm. long, and 7.5 mm. in diameter, and pursues a course downward and forward under the symphysis pubis. The mucous membrane is stratified epithelium, except near the bladder where it becomes a transitional type. Many small mucous glands lined with columnar epithelium dot the anterior portion, and Skene's glands empty into it at or near its external orifice. The muscular layer consists of inner circular and outer longitudinal fibers. The external layer is fibrous tissue.

Imbert and Soubeyran say that the female urethra represents embryologically that part of the female urethra which is never involved by gonorrhea; therefore, the gonococcus can never be a cause of stricture here. Most authors, however, state it is the most common cause, especially Kleinwachter, Herman, Wynne, Pugh, Stevens and Bagot who claims that one-third of the cases are so caused, but that the stricture does not appear for from five to eight years after the acute onset. Pugh claims that 90 per cent of his cases were due to gonorrhea.

From the case reports in the literature, this is well borne out as follows: gonorrhea, 121 times; carcinoma, 50; obstetrical, trauma, 38; traumatic, 19; syphilis, 17; non-specific infection, 15; congenital, 13; senile thickening, 12; polyps, 9; spasmodic type, 5; calculus and infection, 4; gonorrhea and lues, 4; ulcers, 4; chancroid, 4; benign tumors, 3; electrolysis, 2; post-operative, 2; lupus, 2; kraurosis vulvae, 2; typhoid, 2; and one each of the following conditions, typhus fever, fissure, masturbation, tuberculosis, burn, scarlet fever,

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diphtheria, keloid, sarcoma and melanosarcoma. To these I would add 4 cases, whose etiology could not be proved bacteriologically, but clinically seemed certain; 1 from gonorrhea, 1 from chancroid associated with gonorrhea, 1 from a luetic ulcer and gonorrhea, and 1 from nonspecific infection associated with calculi.

Contrary to Kleinwachter's opinion that tumors rarely cause stricture, and if they do only in the beginning, about 50 per cent of the reported cases produced stricture, and most of these in the last six months of the disease. It is interesting to note that only 1 case was reported as due to tuberculosis, which is about as infrequent as for the male, according to Young.

Some question is raised by the author relative to the classification of the following 2 cases reported as congenital strictures, as they do not fulfil Young's requirements: namely that the history of difficulty in voiding should begin from birth, and that there ought to be hypertrophy and dilatation of the bladder, ureters, and kidney pelves. One patient having pyelonephritis yet showing a negative specific history, stated that her trouble began in adult life. The other, a woman of thirty, who had a pearly-white diaphragm in the urethra with a central perforation, gave a history of difficulty of only two years' duration, and a combined infection of gonorrhea and syphilis. Some authors claim that a pearly-white membrane with a central perforation always indicates a congenital stricture. This is not true, because last year I saw such a membrane in a male urethra where a stricture, due to gonorrhea, had been dilated three years before.

I cannot agree with Boyd when he interprets all children's urethras which will not admit a French No. 20, as congenital strictures, because in the treatment of genital infection in children many urethras will not admit over a No. 16 catheter.

I do not believe that these so-called soft strictures, really edema of the mucosa, should be classified as true strictures, because if the edema subsides, the trouble disappears without resort to dilation. Every one has seen cases where retention has followed an alcoholic spree, or a severe chilling from a long ride in the winter, or after sitting through a football game. Just recently I saw a man thirty-eight years old who having drunk profusely the night before, had retention, due to congestion.

Interesting, too, but differing considerably from the male is the location reported most frequently involved by the stricture: anterior third, 86; middle third, 18; posterior third, 12; entire urethra, 12. There were a few cases of multiple stricture reported. These were not included in the figures, nor were those due to carcinoma, which usually involved the whole canal.

One cannot draw any accurate conclusions as to the period of life when these strictures, due to inflammatory processes, begin, because the age was stated only in 137 of the 431 cases recorded. However, it would appear that most occur during middle life. On the contrary, a rather accurate period can be established for those caused by malignancy, since the age was reported in 42 of the 48 cases, as is easily seen in the following chart:

Age	Inflammatory	Malignancy
under 1 year	3	0
1–10	4	0
10–20	6	0
20–30	31	2
30–40	36	7
40–50	29	4
50–60	17	18
60–70	11	10
70–80	0	1

The size of these strictures can be stated only with relative accuracy because of the many types of instruments used; but reducing those given to a single scale, we have approximately the following from the literature which shows that the filiform or near filiform is the most common.

21–26 French bougie	3
16–20	3
11–15	8
6–10	14
Filiform—5 French	42
Filiform	70

Pugh states that if a French No. 16 or smaller cannot pass, it constitutes a stricture, especially if symptoms of difficulty in voiding and frequency are present. Lerouelle says some strictures will allow only a French No. 20 to pass. Bugbee and Cheetham classify a condition allowing French 22 or smaller, a stricture. Stevens calls everything that permits a French 26 to pass, one, if any bladder symptoms are present and reports 173 such cases out of 234 patients examined for bladder trouble, although he states that only 56 had real symptoms. On the other hand Herman measured 55 normal cases where only a French No. 17 could be passed. Bugbee reports 692 cases in 1000 of patients complaining of frequency, Cheetham 16 in 100, Winkel 3 in 3000 gynecology admissions, Fischer 4 in 4000, Hamonic 12 in 5000.

These strictures varying from a thin membrane to a bridge of tissue, may cause very serious complications. It is interesting to note that in the available literature, no case of female urethral fistula is recorded, except one reported by Winchel due to an ulcerating carcinomatous stricture. Young states that damage to the bladder, ureters or kidneys is rare in strictures of the urethra because if the bladder empties at all, it usually does so completely. There was no damage to the ureters or kidneys in one of my cases even when for several years, there was constant retention in the bladder of over 300 c.c. On the other hand Kreutzmann[94] states that a considerable number of cases where urethral obstruction was present for some time, showed a dilation of the ureters and kidney pelves. This he believes is due to hypertrophy of the bladder muscles causing constricting bands about the lower ureters. Autopsy reports of various cases have shown enlarged, thickened, and trabeculated bladders; dilation and hypertrophy of ureters and kidney pelves; enlarged and thick-walled kidneys. According to Heinricksdorff a purulent cysto-ureteropyelonephritis was present in 2 cases of stricture following a cicitricial contraction of vesicovaginal fistulas caused by childbirth trauma. Tuckermann in 1899 reported a congenital stricture in a girl five years of age whose autopsy report showed the bladder distended to the umbilicus, the walls very thick, and a very small cavity in the fundus of the bladder full of pus from which a staphylococcus was cultured, both ureters irregularly dilated, and both renal pelves markedly enlarged. Stevens claims that 54.5 per cent of ureteral strictures have urethral strictures and in 46.1 per cent of urethral strictures he found ureteral strictures. Hunner according to Stevens found that 85 per cent of his ureteral stricture cases had urethral strictures. On the whole, only a comparatively few complications were reported because relatively few autopsies were performed and only a record of 6 cystoscopies which were performed by Cheetham. No renal functional tests or pyelograms were reported.

The symptoms in the female are the same as in the male: frequency, pain, burning, passing of small amounts of urine, difficulty in starting the stream, straining during voiding, increase in emptying time of the bladder, constant desire, urgency, dribbling and diminution in the size of the stream down to a fine spray or complete retention. Uremic and toxic symptoms such as headaches, drowsiness, depression, irritability and nausea occur. Fatigue, lack of ambition, abdominal discomfort and weakness are complained of. Stanton and Cheetham report renal colic symptoms due to urethral strictures. The duration of symptoms varied from a few weeks to twenty-six years. In cases due to non-malignant causes, the symptoms most often reported in order of frequency are: difficulty in voiding, frequency, pain and dribbling; whereas in those due to malignancy the symptoms are bleeding, frequency, difficulty in voiding, retention, pain and burning.

Treatment varied according to the cause from the simplest procedure of dilation to the radical operation. In that due to malig-

nancy excision of the urethra often with a portion of the bladder was performed in 30 of the 48 cases whereas radium and *x*-ray were used only in 4. In non-malignant strictures gradual dilation was performed seventy-eight times, internal urethrotomy in 31, suprapubic cystotomy and retrograde dilation in 3 cases and rapid dilation, trochar, galvanism and electrolysis in a few.

I want to report 4 cases of stricture of the female urethra I have seen since 1920 in a dispensary service of two hospitals, one for two years, the other for eight years.

Case I. N. M., colored, aged forty-one, was seen March, 1922, complaining of pain in the lower abdomen, of burning, smarting and frequency of urination, of painful and difficult urination, of slowness in starting the stream, of a very small stream, of inability to hold her urine, and of a feeling that she never emptied her bladder. She further complained of nausea, headache, drowsiness, loss of ambition, inability to work, of convulsive seizures, all of which had been present for one and one-half years. She gave a history of antileutic and antigonorrheal treatment since the appearance of a sore about the urethra and a discharge in 1917. Wassermann reaction 4 plus. She had one child seventeen years old.

Examination revealed a soft, tender mass in the lower abdomen reaching half-way up to the umbilicus. The cervix presenting a little discharge was in mid-position. The mass felt covered the uterus both anteriorly and laterally. The urethral orifice was a displaced depression, the result of scarring about the site of an old ulceration. It would not admit a No. 10 F. catheter. Therefore, I had her void while on the table to see if the urine did pass through the depressed place, and she passed a fine spray-like stream. The depression was filled with filiforms and one jumped through a small opening under the bridge of tissue that overlapped the orifice. A No. 12 metal follower was attached and forced through removing 350 c.c. of urine. The supposed pus tube disappeared. The urethra was dilated periodically until April 3, 1922, when a cystoscopic examination showed congestion and trabeculations about the trigone and posterior wall of the bladder. Catheters were passed uninterruptedly to the kidney pelves. Each held 10 c.c. Indigo carmine functional test was performed, 5 c.c. intravenously. The appearance time was four minutes. After collection for ten minutes the right kidney secretion was normal and 25 per cent more than the left kidney. Phthalein test was 55 per cent in two hours.

Case II. C. S., colored, twenty-eight years old, presented herself on Jan. 20, 1927, complaining of pain in the lower right abdomen, of frequency of urination, occasionally every five minutes, of difficult voiding over a period of six years, of nycturia four to five times. She had been married for twelve years and had one child that died at six months of age. She had had leucorrhea for two years and bilateral Bartholin gland abscesses, urethral polyps and a cicatricial scarring from a chancroid, which produced a stricture of the urethra. Wassermann test was negative and no gonococci were found. Both glands were excised and several polyps ½ in. long were removed from the urethral orifice. A stricture filiform in size which was situated ⅓ in. within the urethra, was dilated.

Cystoscopic examination was done and pyelograms made on February 7. The bladder mucosa was somewhat congested but had no trabeculations. Number 6 catheters were passed uninterruptedly to the kidney pelves. Indigo carmine test was normal. Both kidney specimens contained a trace of albumin, WBC, RBC and B. coli. Pyelograms showed the right kidney enlarged but no change in either pelvis except that the major calyces showed a little unusual branching. There was no evidence of calculi.

Case III. F. B. colored, aged forty-seven, came in complaining of nycturia, some difficulty in voiding, frequency and a vaginal discharge. She had had an operation for fibroid uterus and pus tubes fifteen years ago. Prior to this she had had two spontaneous miscarriages. The cervical smear showed no gonococci. Wassermann test was positive. The urethra would only admit a No. 10 F. dilator but was easily dilated as the stricture was formed by an induration of the wall in the anterior third of the urethra. B. coli was cultured from the bladder urine. She refused cystoscopy, so dilation of the stricture and antiluetic treatment only were done. This stricture, I believe, was due to gonorrhea as there was no evidence of any ulceration or scars.

Case IV. This woman, M. McA., seventy-

three years old, colored, was seen in Oct., 1928, complaining of blood in the urine for six months, of bladder trouble for thirty years, of frequency, often every fifteen minutes, of passing small amounts of urine, of dysuria, of difficulty in voiding, of a small stream, of urgency, of nycturia four to five times, of passing sand and pebbles for the last three days. She had cramping pains in the kidney regions, radiation to the lower back, groin, and to the anterior surface of the thighs. There was no venereal history, but she and many of her family gave a history of tuberculosis.

Examination revealed tenderness over both kidneys and bladder. The urethral orifice was small and the canal rope-like to palpation throughout its entire length. The ureters were not felt bimanually. There was no vaginal discharge. The uterus and adnexa were small and located normally.

The stricture was dilated from a No. 12 F. to 26 and cystoscopic examination showed much congestion of the bladder mucosa, and many large trabeculations behind the trigone. A small white stone was removed. The ureteral orifices were very prominent and congested. A No. 5 catheter could not be passed over 2 cm. into the right ureter. A filiform was passed and then a No. 4 catheter. Only a filiform could be passed into the left ureter. Catheters met an obstruction 3 cm. within. Specimens collected were blood-tinged. Indigo carmine, 5 c.c. injected intravenously, appeared from the right kidney in five minutes and from the left kidney in eight minutes. Collection for a ten-minute period was about 60 per cent from the right and 40 per cent from the left kidney. *X*-rays showed the right kidney pelvis normal and the left slightly enlarged. No calculi were present. Cultures showed a staphylococcus in the bladder specimen but no growth from either kidney. Further treatment consisted of urethral dilation and bladder irrigations. The ureters were dilated to a No. 8 F. and the urethra to a No. 28 F.

In conclusion, it seemed to me several important facts could be deduced from all these case reports.

1. That gonorrhea is the most frequent cause of stricture of the female urethra.
2. That carcinoma is a far greater cause of stricture than is generally supposed.
3. That all strictures reported as congenital should fulfill Young's rule.
4. That dilation and hypertrophy of the ureters and kidney pelves are not frequently associated with stricture of the urethra with the exception of the congenital type.
5. That all cases should be completely studied by cystoscopic functional tests, and *x*-rays taken to determine all the accompanying pathological changes.
6. That the so-called soft stricture should not be classified as a stricture.
7. That the female urethra should not be overlooked in examination.

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STRICTURES OF THE URETER*

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IN the last few years there has been much work directed toward clarifying the understanding of ureteral stricture of non-tuberculous origin, its cause, diagnosis, symptoms and pathology. Yet the work is not completed. There is still a great deal of discussion relative to the manner of diagnosis, and also to the various causes and the existing pathology.

It might be well to review for a few minutes the opinion on pathology of ureteral stricture. Hunner first described ureteral strictures as narrow and wide. The wide type of stricture has received most attention because it has seemed to be the most difficult to agree upon. Hunner claims that a wide stricture is due to a cicatricial band around the ureter causing a thickening and at times a swelling that is sufficient to partially occlude the ureter; that the wide stricture does not necessarily cause evidence of back pressure, that it may cause no obstruction to a catheter. The wide stricture is considered to be of the acquired type. On the opposite side, Braasch and his following are very dubious about the existence of anything like a wide stricture because there is no way of accurately determining it. There is also the congenital stricture which is now believed to be not infrequent. Campbell of New York reports ureteral stricture in 1 per cent of 13,000 necropsies done at Bellevue Hospital. Campbell also reports in a study of 2420 pediatric autopsies an incidence of ureteral blockage of 2 per cent. Over 50 per cent of these cases were due to intra-ureteral narrowing and most of them were congenital.

Carson of Milwaukee reports that in 300 consecutive autopsies done at the University of Maryland he found 8 cases of pronounced inflammatory ureteral stricture and 3 cases of congenital stricture. On the other hand, Dr. Aschner claims that ureteral stricture is extremely rare and that the cases seen at Beer's Clinic in New York could all be counted on the fingers of one hand. I am convinced that this opinion does not reveal the true situation because in my own experience I have demonstrated unquestionably a large percentage of ureteral strictures and I am only including those cases that have shown marked undeniable evidence in the *x*-ray film of the lesion. We must recognize the fact that there are different pathological stages in every case. Some cases will show evidence of ulceration with little scar tissue; some will show even earlier stages of inflammation where the process has been slow and in these cases usually the back pressure is not evident all the way to the kidney if the lesion is low in the ureter; then some cases will show a full and complete scarring when the blockage is due practically entirely to the contraction of the scar and in only a small measure to the active swelling resultant from the inflammation. It is not necessary as Carson claims that every case show kidney stasis. One might be dealing with an early case that has not gone that far.

Pathological end-results of ureteral stricture, of course, are ureteral and kidney stasis and infections above the stricture often leading to complete destruction of kidney.

Hunner reports many conditions due to ureteral stricture such as (1) essential hematuria (2) hydronephrosis (3) pyonephrosis (4) pyelitis (5) urinary calculi (6) some medical nephritides (7) much of the pathology in congenitally malformed kidneys and many so-called bladder neuroses.

Etiology: What causes all these ureteral strictures? I believe that the common

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pyogenic organism is in nearly all cases the exciting cause. I have not been able to demonstrate one case of gonococcus infection in this study. These cases all have negative Wassermann reactions. The colon bacillus, the staphylococcus and streptococcus have been the offenders either alone or together. One case of pure culture of micrococcus catarrhalis was found. In Sugimuras' autopsy study of the lower ureter in 25 cases of patients having infection in the bladder who died from other causes, he found marked inflammation which seemed to him to have traveled into the ureter through the lymphatics rather than by the mucosa.

Severe inflammation of tube and ovaries would seem to be an ideal cause for the origin of ureteral stricture, yet Hunner states that in his wide experience he has yet to see a case that he could definitely say was due to this cause. Dr. Scott Pugh of New York reports obstruction of the lower ureter due to seminal vesiculitis but does not show any *x*-ray evidence of stricture. He claims that the obstruction does not go on to stricture formation but subsides with the vesiculitis.

Not considering trauma I believe that most ureteral stricture can be traced to hematogenous infection from distant parts of the body; appendix, tonsils, teeth, gall bladder and so on. One patient here shown suffered from recurrent attacks of appendicitis over a period of several years. During one acute attack the badly infected appendix was removed. Ten days postoperative the patient suddenly developed a severe pain in the left kidney region, colicky in nature and associated with bloody urine. Kidney stone was suspected so we cystoscoped him and found a strictured left ureter with acutely distended kidney pelvis from which 18 c.c. of bloody pussy urine gushed through the catheter. A symptomless stricture was also found on the other side. All the patient's symptoms disappeared after the first dilation and we have now dilated him the third time to the size of a No. 9 F. catheter.

SYMPTOMS

Probably the most important and the most leading of all symptoms is that of pain, in many cases of dull aching, vaguely located pain, sometimes in the lower right or left quadrant of abdomen, sometimes in the region of the umbilicus, sometimes higher up in the back. The pain is not usually of a definite and intense character but of such a nature that almost any diagnosis might be made. If on the right side it is usually called appendicitis and operation is advised.

Backache is the next most frequent symptom, commonly located across the small of the back, sometimes high in the kidney areas and less often over the sacrum. The pain is usually dull in character and non-radiating.

Some patients complain of bladder frequency which is intractable until the strictured ureter has been dilated. There may be no demonstrable cystitis and there may be no pus in the urine. The fact that no bladder symptoms occur does not rule out strictured ureter, because 30 per cent of cases show no bladder difficulty.

In women symptoms of ureteral stricture are many times confused with menstrual pain. At first, pain may be associated with menstruation probably because the engorgement occurring during this period causes greater swelling in the mucosa of the pelvic ureter producing more blocking and consequently more pain. After the ureteral stricture has been present for some time, however, these pains continue through the period between the menses.

We suspect ureteral stricture in women who have been having normal periods and suddenly develop menstrual pain and in women who have no other pelvic pathology demonstrable or who have not received relief from dysmenorrhea by childbirth or cervical dilation.

DIAGNOSIS

Most of the discussion and debate going on in this subject of ureteral stricture is

concerned with the diagnosis. When is a ureteral stricture present? Guy Hunner says he can invariably diagnose stricture of the ureter by the hang of a ureteral bougie. To substantiate his claim he has made some interesting experiments. For instance he has had a patient in whom he diagnosed stricture at a certain location in the ureter by means of a hang when removing a bougie and has operated upon the patient. With the abdomen open, the ureter visualized, the patient having been under a deep anesthesia for some time, he has repeated the withdrawal of the bougie and has gotten the same hang at the same location in the ureter. This seems to be definite enough evidence in the hands of Hunner, but who can duplicate it? I confess I have not been able to be certain of a hang even in some cases that were definitely shown to be stricture by other methods.

Depending on the obstruction to a ureteral catheter to diagnose stricture is entirely unreliable because many times the catheter will catch on a fold of mucous membrane or some angulation of the ureter without stricture being present. That will be most misleading. Use of the catheter with the injection of ureter with some opaque solution for a ureterogram is the most reliable method of diagnosis.

There is a new method of visualizing the ureter by means of the injection of an intravenous solution of sodium iodide and urea. This solution has proved extremely satisfactory so far, particularly where there has been any degree of stasis in the urinary flow. There is a great argument in its favor because it visualizes the urinary tract in an undisturbed condition. From the little experience I have had in the use of this preparation, and review of the recent literature, I believe that the problem of discerning any degree, however slight, of a ureteral blockage has been solved.

There have been many experiments made in trying to find a solution that could be used intravenously or by mouth, to visualize the urinary tract. In 1924 as far as I can ascertain, the first experiments were made at the Mayo Clinic. There, a preparation of sodium iodide was used both orally and intravenously but with very unsatisfactory results. In 1924, Von Lichtenberg, also tried by the use of intravenous preparation to get a shadow in the ureter or kidney. He also failed. Several years later Roseno and Jepken of Berlin began attempts with many preparations injected intravenously in order to get a kidney shadow. They finally came back to the use of iodine salts. There experiments with dogs began by the use of a 10 per cent solution of sodium iodide injected into the femoral vein. They got no shadows except in the bladder where the urine was retained over a considerable period of time. These shadows were very poor so they paralyzed the bladder muscle by large doses of morphine prior to the injection of the iodide in order that they might get a longer retention in the bladder. By this means they got a very good picture of the bladder outline, but absolutely none of ureter and kidney. The injection of the iodide almost invariably killed the dog. They resumed their experiments with the injection of iodide, after ligating one ureter. This resulted in a very good outline of the kidney pelvis and ureter on the ligated side. The problem now presented itself of getting a preparation that would throw a shadow in the ureter and kidney, without the necessity of ligating the ureter and without killing the dog.

I believe Roseno was the first man to successfully use a combination of urea and sodium iodide. He thought of urea because of its normal existence in the blood and urine. He experimented with many combinations of the two drugs, until he had now successfully demonstrated that large amounts of sodium iodide can be given intravenously in combination with urea without any untoward effects.

In the early part of 1929, he employed a solution of about 38 gm. of sodium iodide in 300 c.c. of water with a slightly greater

amount of urea. This work was done on human beings after a larger percentage had successfully been administered to dogs. It seems that the presence of urea with the sodium iodide makes the sodium iodide practically non-toxic. The urea being rapidly eliminated by the kidney carries the sodium iodide very rapidly through the kidney. The iodide itself acts as a specific diuretic. The presence of a large amount of sodium iodide and urea in the blood causes a flow of lymph into the blood stream. This also acts to reduce the toxicity of the iodide. The entire injection of 300 c.c. is given over a period of fifteen minutes. It begins to appear in the urinary tract in the kidney that is functioning nearly normally almost immediately. Some cases show a very rapid elimination of the iodide, so that an *x*-ray picture is always taken immediately to ascertain the outline of the kidney pelvis which is sometimes manifested so early. Another picture is taken on the third hour after the injection and also on the fifth hour. In order that the iodide may be retained and its expulsion from the body retarded after it has been secreted by the kidney, the injection is always given with the urinary bladder as greatly distended as possible. The iodide is for the most part eliminated within five hours, although traces are sometimes seen in the urine from twenty-four to forty-eight hours following the injection.

The drug injected seems to be practically non-toxic. Roseno has had no reactions other than some dizziness and headaches immediately following the injection. These symptoms have never been severe and have passed away within a few hours after injection.

Before any injection is made, it is a very wise idea to paint a portion of the skin of the patient with tincture of iodine in order to ascertain whether there is any possible iodine idiosyncrasy. If there is no erythema of the skin twenty-four hours after being painted with tincture of iodine, it is safe to inject the iodide. The only other contraindications for this procedure so far as we know now, are a thyrotoxicosis and pulmonary tuberculosis.

Much work has yet to be done, but I

Fig. 1.

believe that with a small amount of modification this procedure will be standardized in a short time and will eliminate all the controversy going on now over the existence of obstructions in the ureter which are difficult to diagnose by our usual pyleographic methods. I have injected this solution in 1 case. I did not have the courage to use the full dose sent to me of approximately 38 gm. of iodide. I did use half or approximately 250 grains in 200 c.c. of water. I procured a shadow in the renal pelvis which was entirely satisfactory, yet not as pronounced, of course, as it would have been had I injected the whole dose (see Figs. 1 and 2).

Many of the so-called harmless kinks of the ureter if examined closely will give evidence of stricture at the bends or in the immediate region above or below. Kinks and turns are not harmless by any means.

Irregularities of distention above a suspected stricture area sometimes seen are, I believe, explained by an incomplete filling of the ureter and kidney pelvis. There has been some question as to whether a stricture is present because in some *x*-ray

pictures there seems to be a dilatation below the stricture area. This apparent dilatation I believe is usually due to

Fig. 2.

incomplete filling of the ureter. The fluid is injected usually below the site of stricture so that the stricture blocks the upward progress of the fluid; if the injection is not continued long enough or if the patient is not in the extreme Trendelenburg position there will be an apparent dilatation of the ureter below the stricture, particularly so if the ureter is of a large caliber normally. I have been able to show the apparent dilatation of the ureter below the stricture by repeating the urogram and continuing more pressure so that the portion of the ureter above the stricture is completely filled. It may be well to review the innervation of the ureter and kidney pelvis at this point, Possibly some light can be thrown on the explanation of some of these irregular dilatations.

The nerve supply to the ureter comes from the sympathetic nervous system being derived from the vesical, spermatic, inferior mesenteric, and renal plexuses. They form a network around the ureter, the end branches being mostly given to the muscular coats although many branches can be followed to the epithelium. According to some authorities some medullated fibers have been demonstrated.

The nerve supply can easily be disturbed by scar in the epithelium or muscle or by simple irritation to these tissues. Dilation therefore may occur anywhere along the ureter as a result of lack of tone and consequently atrophy of muscle tissue. But usually when urograms are repeated in these cases of atonic dilation the dilatation varies in extent and many times in location; at least enough change takes place so that there is a slight reason for mistake. Just as atony of the ureter occurs so also can spasm of the ureter occur. Usually when spasm occurs there is either a recent infection in the ureter or a highly nervous type of patient; or there has been very little blockage in the ureter. Ordinarily there is no spasm following urogram if a stricture has been present and it is not very tight. Of course when a stricture is dilated and there is considerable trauma from catheterization causing a resultant swelling at the stricture site, then spasm and pain may be exceedingly acute.

If a spasm is suspected in the ureterogram usually all one has to do is to pass a catheter into the kidney pelvis and irrigate with Ag No. 3 once or so and then repeat the ureterogram and the spasm very frequently will not show again. Sometimes when due to a stone in the pelvis a spasm at the ureteropelvic junction is rather constant in the ureterogram. However, when this is the case the patient usually has to have a pyelotomy done and the ureteropelvic area can easily be investigated. Braasch and several others have been able to demonstrate the spasmodic nature of this condition during operation.

Now the question arises as to treatment. Is the treatment dilation? It is the only treatment we have that is a very good one. That the dilation treatment has failed to give permanent cure in some cases is no reason for condemning it as some prominent urologists have done. A scar in the urethra or anywhere else where it is around the circumference of an organ will contract slowly and sometimes rapidly, after it has been stretched wide open. In the urethra we have so-called "gummy"

stricture that has to be cut before it can be dilated to stay for any length of time. So also we have sometimes a gummy type of stricture in the ureter that will not stay stretched for any length of time. The fact that relief sometimes is not rapid or permanent following dilation of the ureter is no reason to say that it is not to be continued or should be condemned. A large percentage of the cases that we have had have been quickly relieved of symptoms following dilation. There are two that have not been relieved after three dilations to the size of a No. 9 F. catheter and did not care to continue treatment, but had they gone to a point where the ureteral drainage had been free I am sure their symptoms would also have been relieved.

Hunner's report of his first 100 cases five years after treatment is interesting: 31 answered as entirely cured; 48 as greatly improved; 31 somewhat improved, and 8 unimproved.

Braasch reports that in 100 cases dilated at the Mayo Clinic 5 answered to complete cure; 10 who had other forms of treatment reported partial cure with subsequent recurrences. The remainder he says were either not relieved at all or just temporarily.

Of the 42 cases in this series 20 have been relieved without recurrence in two years; 12 have been relieved for varying length of time but had to be dilated occasionally to keep symptoms of pain from recurring; 2 were not relieved after several treatments. They were dilated up to the size of a No. 9 F. catheter. I am unable to say whether they would have been relieved if they had been willing to continue further treatments of greater dilations; of 8 we have no follow-up knowledge. Whether they were sufficiently relieved that no further treatment was necessary or whether the pain of the dilation was greater than they cared to suffer I do not know. Now the question arises, how long shall we continue to dilate? As long as the pain recurs and dilation relieves the pain. One patient in this series has been dilated three to four times at weekly intervals every three months for the past three years. She works regularly now and has gained weight; is entirely free from pain following her three to four dilations for periods of three to four months. Her invalidism has been cured.

From my study of these cases my conclusions are (1) that ureteral stricture is a rather common disease; (2) that there is evidence to show that ureteral stricture many times is due to foci of infection in distant parts of the body; (3) many of the vague mysterious pains in the abdomen can be explained by study of the ureteral tracts; (4) that the so-called wide stricture is doubtful; (5) that the bulb method of diagnosis is most difficult, also uncertain; (6) that many of the cases showing dilatation below the stricture are due to faulty filling of the ureter; (7) that dilation of strictured ureter is a very efficacious means of treating the condition, curing approximately 50 per cent and giving great relief for some time at least in a far greater percentage; and (8) repeated dilations are justified over any period of time if the patient is relieved following dilation.

DISCUSSION

Dr. Ferrier: I believe Dr. Mulvehill is a little too enthusiastic in regard to the diagnosis of strictures of the ureter. A stricture has to be consistent and it has to be of uniform length and in some of the pictures which he has shown it did not so easily bear this out.

The other point is this: spasm and kinking very often simulate a stricture so it is necessary frequently in order to be absolutely certain that you have a stricture to take one or two successive plates to prove that it is consistent and uniform in type, size and shape of the stricture.

In regard to the treatment, dilatation, as we all know, is probably the only form of therapy that does any particular good.

Dr. Mulvehill: The cases that I showed were picked out particularly because they had been mulled over so many times.

One girl had been operated on; she had had her gall bladder, tubes, ovaries and appendix removed, and one of our leading internists

told her that her trouble was all in her mind, psychasthenia, and advised a long rest so that she would get over her pain. She did not believe that she was a psychasthenic so she kept travelling around until finally she reached us. We cystoscoped her and found what we believed to be indisputable evidence of ureteral stricture and after her ureter was dilated she was able to go back to work and has had no pain at all. The others are all the same.

I believe that if you get a case of this kind where there is a distinct narrowing of the ureter with a tremendous dilatation or a marked dilatation above that area and the introduction of a bougie through that narrowed area relieves the patient of the distinct symptom, that you have hit something that is pathological. It could not be a spasm that has given the patient a severe degree or a mild degree of pain over a long period of time.

The pain can be most any place, can be referred to the back, or a typical appendiceal pain, can be on one side or the other. That is the misleading factor about it.

Dr. Criley: Does it ever refer to the extremities?

Dr. Mulvehill: The pain is rarely radiating as it is in ordinary kidney stone. These cases that I showed on the screen were cases that had no urinary findings so the examining doctor concluded that the urinary tract was okay. That is one reason that the urinary tract was never inspected.

I believe with Dr. Belt that the introduction of sodium iodide and urea is going to clear up this question entirely. I believe that the solution will show the slightest amount of blocking along the ureteral tract and I think that most of the difficulties are practically solved by this method.

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*Continued from p. 250.

A UNIFIED PLAN FOR KEEPING RECORDS OF CARCINOMA OF THE UTERINE CERVIX*

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IN the study of cancer generally, the large amount of work that has been done with radiotherapy in cancer of the uterine cervix deserves more than casual attention by the surgeon, even if it were for no other reason than to learn how cancer responds to radiological treatment, or to determine whether some of the principles that have been revealed in the therapy of cervical growths are applicable elsewhere.

The basic requirement in scientific work is an accurate record. In clinical research, the patient who is, as a rule, untrained in observation concerning medical matters, becomes a factor. The shortcomings of the interne in training, on whom the task of obtaining histories usually devolves, must be taken into account. Finally, the findings which one attending surgeon dictates, may not tally in grouping or detail with those of another, because of personal equation or difference in standards according to which an estimate of the condition is formed.

For such reasons as these, records need to be standardized to make them uniformly serviceable for comparative study. This can be done by formulating a syllabus of the guiding lines along which data are to be obtained and recorded.

In a working system of this kind the record sheets should cover, firstly the Admission, secondly the Revision, and then the Final Summary. Each outline can be printed on quarto-size paper to fit the patient's chart and each sheet perforated at one margin for binding, in conformity with the plan adopted for record sheets by the New York City Hospitals. Whenever the case is one of cancer of the cervix, the special sheets can be added to the patient's chart and the pertinent facts entered in due course.

A satisfactory system for recording is an important preliminary in the plan to inaugurate and unify the study of cervical cancer in various instutitions. The accompanying scheme is based on clinical study in the service at the New York City Cancer Institute from May 1923 to November 1929 during which time, all of the patients who were suffering from carcinoma of the uterine cervix, came under my supervision.

* Submitted for publication December 9, 1930.

CANCER OF THE CERVIX UTERI—*ADMISSION SHEET.* Page 1

Date of *Admission*.....

Case.....Name.....Occ.....Record No.....

GENERAL HISTORY.

Age....Race.....S.M. No. of pregnancies....

Age when menstruation began?....Original duration?....Quantity—slight, moderate, profuse? Clotting?....Color?.....Pain—before, during, after menses?.....Location of pain?.....Menstrual interval (type)?.....

What changes not referable to neoplastic disease, occurred in the menstruation later?.....

When were these changes first noticed?.....

Menopause?....M by crisis, lysis, or interrupted lysis?.....Age?.....

Formerly subject to vaginal discharge?....What was its character?.....

.....When first noticed?.....

Wassermann test made?.....Result?.....

Family history of cancer or tumor?.....

HISTORY OF THE PRESENT DISORDER.

When did the first complaints referable to neoplastic disease appear?....months ago?....What was the complaint?.....

When was anomalous bleeding first observed?.....months ago.

When was anomalous discharge first noticed?....months ago. Its character?.....

.....

Advent of pain?.....months ago. Location of pain?.....

.....

Other early suggestive symptoms?.....

.....

Estimated probable minimum duration of the growth or age of growth at time the treatment was started?.....months.

When was medical advice first sought?....months ago. What advice was given?.....

.....

Chief complaints on admission.....

.....

.....

Does any medical disorder coexist which may complicate the course and treatment of the neoplastic disease?.....

.....

Admission Sheet.....Institution.....

Case.....Name.....Admission Date.....Record Number.....

Complete Diagnosis on Admission.....

.....

Total Previous Therapy.....

Result on Admission.....

Admission Sheet.....Institution.....

Case.....Name.....Admission Date.....Record Number.....

Complete Diagnosis on Admission.....

.....

Total Previous Therapy.....

Result on Admission.....

CANCER OF THE CERVIX UTERI—*ADMISSION SHEET.* Page 2

PREVIOUS PELVIC THERAPY AND INDICATIONS.

Any previous treatment for catarrhal or suppurative endotrachelitis?.....
Any previous operation on the cervix?....Nature of operation?.....
Any pelvic organs removed at previous operation?.....

.....

What diagnosis was made?.....
Was the diagnosis determined by clinical examination, operative findings, or tissue section?.....

Any previous *x*-ray treatment?....Form of *x*-ray application?.....
Total milliampere hours received (M.A. hrs.)?.....Total time-span through which *x*-ray treatments were distributed?.....Total milliampere hours divided by total time-span in days, gives the daily average M.A. hrs. of *x*-ray treatment received—the treatment distribution index (X.D.I.)?.....

Any previous radium treatment?....Form of application?.....
Total millicurie hours received?.....Total time-span through which the radium treatment was distributed?.....Total millicurie hours divided by total time-span in days represents the radium treatment distribution index (R.D.I.)?.....

CLINICAL STAGE OF THE GROWTH ON ADMISSION.

Carcinoma of Cervix I—the lesion is confined to the cervix as determined by speculum, sound, and rectovaginal examination.....
Carcinoma of Cervix II—the limits of the cervix have been reached.....
Carcinoma of Cervix III—the lesion extends beyond the limits of the cervix.....

Extension to corpus?....Extension to vagina—distance from introitus in inches, stated clockwise at four cardinal points?.....
Isolated vaginal deposits?.....
Extension to broad ligaments—Ext. right B.L., left B.L.?.....
Extension to sacrouterine ligaments—Ext. right S.L., left S.L.?.....
Cervix completely fixed?....Sacral nerves involved?.....

.....

Hydronephrosis?.....
Secondary pyometra.....Parametritis septic active?.....
Does a rectovaginal fistula exist—Carcinoma of cervix III with R-V.F.?.....
Is a vesicovaginal fistula present—Carcinoma of cervix III with V-V.F.?.....

Chloro-anemia—slight (Hb70), moderate (Hb50), severe (Hb30)?.....
Toxemia degree estimated from extent of bacterial invasion of lesion and symptoms mild, moderate, severe?.....
Complete diagnosis on admission.....

.....

.....

Revision Sheet.....Institution.....
Case.....Name.....Revision Date.....Record Number.....
Complete Diagnosis on Revision.....
.....
Total Therapy Op.?.....X.D.I.?.....R.D.I.?.....
Result to date....Cured?....Improved?....Unimproved?....Died?....

CANCER OF THE CERVIX UTERI—*REVISION SHEET*. Page 1

Date of *Revision*.....Name.....

THERAPY APPLIED FOR NEOPLASTIC DISEASE AFTER ADMISSION.

Surgery—Date.....Nature of operation performed.....
.....
.....
Findings at operation?.....
.....
Clinical Diagnosis verified by operation findings? by tissue section?.....
.....
Cautery—Date.....What method used?.....
.....
.....
X-ray—Date.....Form of *x*-ray application.....
Dates and M.A. hours received?.....
.....
.....
Total milliampere hours received?.....Total time-span through which *x*-ray treatments have been distributed?.....Total milliampere hours divided by total time-span in days, represents the treatment distribution index (X.D.I.)?.....
Radium—Date.....Form of application?.....
.....
.....
.....
.....
Total millicurie hours received?.....Total time-span in days through which the radium treatments have been distributed?.....
Total millicurie hours divided by total time-span in days, represents the radium treatment distribution index (R.D.I.)?.....
Other Methods—Date.....Nature and application?.....
.....

CANCER OF THE CERVIX UTERI—*REVISION SHEET.* Page 2

Revision Sheet.....Institution.....
Case.....Name.....Revision Date.....Record Number.....
Complete Diagnosis on Revision.....
.....
Total Therapy Op.?.....X.D.I.?.....R.D.I.?.....
Result to date——Cured?....Improved?....Unimproved?....Died?....

SUPPLEMENTARY HISTORY OF NEOPLASTIC DISEASE.

Hemorrhage—Date.....Quantity?.....Frequency?.....
Discharge—Quantity?.....Character?.....
Back pain?....Location?.....Thigh pain?....Location?.....Iliac pain?.....right, left?.....Hypogastric pain?...
.....
Retention of urine?.....Dysuria?.....Incontinence, urinary (V-V fistula?)?.....
Constipation?.....Dyschezia?.....Incontinence fecal (R-V fistula?)?.....
Complaints referable to remote metastasis? Other complaints?.....
.....

CLINICAL STAGE OF THE GROWTH ON REVISION.

Carcinoma of Cervix I—the lesion is confined to the cervix as determined by speculum, sound, and rectovaginal examination.....
Carcinoma of Cervix II—the limits of the cervix have been reached.....
Carcinoma of Cervix III—the lesion extends beyond the limits of the cervix.....
Extension to corpus?.....Extension to vagina—distance from introitus in inches, stated clockwise at four cardinal points?.....
Isolated vaginal deposits?.....
Extension to broad ligaments—Ext. right B.L., left B.L.?.....
Extension to sacrouterine ligaments—Ext. right S.L., left S.L.?.....
Cervix completely fixed?.....Sacral nerves involved?.....
.....
Hydronephrosis?.....
Secondary pyometra?.....Parametritis septic active?.....
Does a rectovaginal fistula exist—Carcinoma of cervix III with R-V.F.?.....
Is a vesicovaginal fistula present—Carcinoma of cervix III with V-V.F.?.....
Chloro-anemia—slight (Hb 70), moderate (Hb 50), severe (Hb 30)?.....
Toxemia degree estimated from extent of bacterial invasion of lesion and symptoms—mild, moderate, severe?.....
Complete diagnosis on revision.....
.....
.....

Summary Sheet.....Institution.....
Case.....Name.....Summary Date.....Record Number.....
Complete Diagnosis.....
.....
Total Therapy Op.?.....X.D.I.?.....R.D.I.?.....
Result to date—Cured?...Improved?...Unimproved?...Died?.....

CANCER OF THE CERVIX UTERI—*SUMMARY SHEET.* Page 1

Date of *Summary*.....Name.....

RESULT OF TREATMENT.

A. *Clinically Cured?*—Free of symptoms and signs at the time of examination?.....

.....

B. *Improved?*—Slightly, moderately, greatly—shows regression, healing response or replacement sclerosis without extension elsewhere....

Estimate of General Status—General nutrition, improved or unchanged?.....
Chloro-anemia—mild, moderate, severe?.....
Toxemia—slight, moderate, pronounced?.....
Is syphilis tertiana present?.....

C. *Unimproved?*—Local lesion unchanged or advanced?.....

Extension to vagina or uterus?—extent of vaginal invasion?—distance of crater rim from introitus at four cardinal points, anteriorly, left, posteriorly, right, stated clockwise and estimated in inches?.....
Extension to broad ligaments or sacrouterine cellular tissue as ascertained by rectovaginal examination.....
Fixation of cervix?.....Involvement of sacral nerves?.....
Hydronephrosis?.....Secondary pyometra?.....
Parametritis septic active?....Rectovaginal or vesicovaginal fistula?.....
Involvement of peritoneum and omentum?....Metastasis in regional lymph nodes?.....
Metastasis remote?.....
Hemorrhage—frequency and quantity?.....
Discharge—slight, moderate, profuse?.....
General Status—General nutrition?.....
Chloro-anemia—mild, moderate, severe?.....
Toxemia—slight, moderate, pronounced?.....
Is syphilis tertiana present?.....

D. Died—when?.....

Immediate cause of death?.....
.....
Autopsy findings?.....
.....
.....
.....
.....

Summary Sheet.....Institution.....
Case.....Name.....Summary Date.....Record Number.....
Complete Diagnosis.....
.....
Total Therapy Op.?.....X.D.I.?.....R.D.I.?.....
Result to date—Cured?....Improved?....Unimproved?....Died?....

CANCER OF THE CERVIX UTERI—*SUMMARY SHEET*. Page 2

Retrospect.

Estimate of biological malignancy based on histologic type, rapidity of growth and penetration—B.M., mild, moderate, marked?.....
.....
Tumor anaplastic or well differentiated microscopically?.....

Surgical risk, average? maximum? Specific reasons?.....
.....
Outlook for cure with surgery?.....

Has the growth shown itself radioresistant (r.r.)? radiosensitive (r.s.), or indifferent?

Post radiation sclerosis slight, average, or pronounced, clinically or microscopically?.....
Tendency to focal reappearance of growth after radiation treatment—marked, average, slight?.....

Estimated time elapsed before the neoplasm was treated?.....

Time elapsed since the beginning of treatment?.....months.
Total therapy—Op.?.....X.D.I.?.....R.D.I.?.....
Total duration of the neoplastic disease?.....months.

Diagnosis complete.....
.....
.....
.....

Final outcome.....

THE RELATIONSHIP BETWEEN

APPENDICITIS AND RIGHT OVARIAN RETENTION CYSTS*

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WHEN operating for appendicitis in the female, the writer has been impressed with the frequent co-existence of right ovarian cysts as compared to left-sided cysts. This combined pathology has occurred so often, that a study was made of 167 female patients operated upon for appendicitis at one institution over a period of two and a half years. Cases of suppurative and perforated appendicitis are not included in this study for obvious reasons. Complicating the pathological appendix, there were 23 right ovarian cysts (13.7%), in contradistinction to 4 left ovarian cysts (2.4 per cent). In many instances, an ovarian cyst was detected or suspected before operation, where the signs of appendicitis were not pronounced enough to prevent careful examination.

Bonney[1] believes that since the diseased appendix may lie in close proximity to the right adnexa, accurate diagnosis may be impossible. Nor does it matter as long as the correct treatment is recognized: namely, to operate upon the patient.

FIG. 1.

At the outset, let it be stated that a careful attempt was made to eliminate other pathological processes as the cause of ovarian cysts. Cases of apparent inflammatory adnexal disease have been excluded, as well as every type of ovarian tumor other than simple retention cyst. The latter consist of Graafian follicular and corpus lutein cysts.

ANATOMIC EVIDENCE

Under normal conditions, the tip of the appendix usually lies in the pelvis with the right tube and ovary, (Graves[5]). In cases of ptosis or cecum mobile, the appendix may lie completely in the pelvis, even as low as the floor of Douglas' pouch. The appendiculo-ovarian ligament, also termed Clado's ligament, (Campbell,[2] De Lee[3]) is a prolongation of peritoneum in the female

* Submitted for publication December 31, 1930.

extending from the mesoappendix to the broad ligament and the right ovary. Herein is contained the appendiculo-ovarian artery which forms an anastomosis between the appendicular and ovarian vessels, thus conferring a greater vascularity upon the female appendix, a suggestive reason for its greater immunity against appendicitis in females.

Communications have been described as existing between the appendicular lymphatics and those of the broad ligament of the uterus as well as the iliac nodes. Deaver[4] states that the lymphatics may empty into those of the ovary by passing along the appendiculo-ovarian ligament. In this fashion a lymphatic communication is established between the appendix and the right ovary. More recent observations, however, have failed to confirm the existence of any direct connection between these structures, (Piersol,[8] Kaufman[6]). Pathological conditions of the broad ligament, ovaries, and iliac nodes associated with acute appendicitis may perhaps be due to a dissemination of the infection through the subperitoneal lymphatic network by way of the appendiculo-ovarian ligament. Graves[5] believes that this inflammatory extension from an acutely inflamed appendix may cause such serious damage to the genital organs in young girls, that among other lesions chronic thickening of the cortex of the ovaries may result. If the attack occurs before puberty, or in young children, full genital development may be curtailed, resulting in infantilism with its symptoms of amenorrhea, dysmenorrhea, neurosis, and sterility.

PATHOLOGICAL SEQUENCE

The underlying causes of retention cysts are numerous. The commonest cause, interstitial oophoritis, may be acute or chronic, (Nelson[7]). Acute oophoritis is usually secondary to an acute perioophoritis which in turn follows in the path of acute pelvic peritonitis, as in acute gonorrhea. Or it may be primarily interstitial as a complication of mumps, acute fevers, lymphangitis of acute septic puerperal or surgical infection.

Chronic oophoritis may be the residuum

Fig. 2.

from any of the foregoing acute states, or may be chronic from the beginning. The condition is essentially inflammatory in origin, whether the pelvis is the seat of gross inflammatory lesions or not. The essential lesion consists in a sclerosing process involving the interstitial tissues. This leads to hardening of the tunica albuginea and inability of the Graafian follicles to rupture when mature. The follicular membrane undergoes hypersecretion similar to that of any serous membrane that is subjected to the chronic irritation of infection. The result is a retention cyst of any size. And a right retention cyst in the presence of appendix infection, suggests the appendix as the etiological factor.

SYMPTOMATOLOGY

No age is exempt from the presence of ovarian retention cysts. Patients in the age of puberty as well as women advanced in years may be afflicted. Our average age incidence was twenty-seven years. Nine

patients or 39 per cent were single, and 14 or 61 per cent were married. Of course, many cysts are not detected preoperatively in unmarried women, unless quite large in size. Scant flow, irregular menses, premenstrual and co-menstrual pain, and metrorrhagia may yield a clue. When a satisfactory bimanual examination is possible, right adnexal tenderness, and in further advanced cases, an ovarian mass may be elicited, in addition to the signs and symptoms of appendicitis.

Ross[9] reported a case of a twelve-year old girl who had an ovarian cyst; the right ovary twisted on its pedicle 2½ turns. The appendix was found in a state of chronic inflammation and was likewise removed. He was of the opinion that a twist of the pedicle of the ovarian cyst had been occasioned by the active peristalsis of the bowel produced by an acute exacerbation of a chronic appendicitis.

CONCLUSION

1. A statistical analysis of 167 cases of appendicitis in the female is presented, 23 of which showed upon operation, right ovarian retention cysts in contradistinction to only 4 left-sided cysts.

2. An anatomic relationship exists between the appendix and right ovary, whether due to the normal proximity of the organs or to lymphatic and vascular pathways.

3. Chronic oophoritis resulting from appendiceal infection causes a sclerosing of the tunica albuginea, failure of the follicles to rupture when mature, hypersecretion of the follicular membrane, and the resultant retention cysts.

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*Continued from p. 290.

SUBPERITONEAL CHOLECYSTECTOMY

PRELIMINARY CLINICAL REPORT OF A NEW METHOD*

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THE aim of modern surgical technique is to accomplish its purpose with the least possible damage to the tissues. By careful, patient employment of available methods of diagnosis the lesion should be located and defined; then it should be handled by direct, specific methods. Such an ideal is not always possible of attainment, but through well directed effort it is becoming more so. An attempt in this direction has been made in the technique to be presented for cholecystectomy.

In 1899 Doyen first removed the gall bladder subperitoneally and drained through the resulting peritoneal sac. This was done with an abdominal incision of the usual length and with gauze packing for exposure. The method had the advantage of decreased risk to other structures in cholecystectomy from above downward, and furnished a tract for drainage. It is an excellent procedure for the removal of gall bladders from which the serosa will strip readily. It can be done with safety through a much smaller incision than removal from below upward, starting the dissection at the cystic duct.

The method to be described uses the principle of subserous resection through an opening in the abdominal wall just large enough to deliver the fundus of the gall bladder, avoiding the necessity of packing for exposure. Experimental results on dogs have been published.[1,2] The method was so effective in these animals that no contraindication could be seen to its use in the clinic. The success of its application is indicated in the following pages.

The first essential is to locate the gall bladder accurately; the next is to be certain that the gall bladder is the only organ involved; and finally to determine that its serosa will strip readily. This knowledge is obtained by study of the case through history, laboratory tests, etc., but chiefly by *x*-ray examination. Given certain cholecystographic signs with a consistent history, negative gastrointestinal series by *x*-ray, normal icterus index, urine, and blood, we can be almost sure that the gall bladder is the seat of the disturbance and that it is not firmly adherent to other viscera.[3] If the study has been diligent we are justified in removing the gall bladder without exploration of the abdomen. The criterion for determining that the serosa will strip readily is pronounced reduction of the cholecystographic shadow after a fat meal. Reduction[4,5] depends upon contraction of the intrinsic musculature of the gall bladder. If this is pronounced there can be no sclerosis and thus no abnormal adhesion of the serosa to the visceral wall.

A two inch abdominal incision is made, not over the fundus of the gall bladder, but, as near as may be estimated from the *x*-rays and percussion of the liver, over the cystic duct, because this is the least movable portion, to which there should be a direct approach. This will generally be from a point just below the costal margin and about one inch to the right of the midline, splitting the rectus muscle. Small abdominal-wall retractors are inserted, opening the wound. If the fundus of the gall bladder is not located at once it can be found readily enough, with the aid of a ribbon retractor, to the right of the opening. It is grasped with a soft intestinal clamp or an Allis clamp and, since it is usually movable, is pulled up into the wound.

* From the Surgical Clinic of the Massachusetts Memorial Hospitals, the Evans Memorial, and the Department of Surgery, Boston University School of Medicine. Aided by a grant from the Committee for Scientific Research of the American Medical Association. Submitted for publication November 28, 1930.

If this cannot be done the technique cannot be employed. Then a triangular-tipped Collins clamp (Fig. 1) is applied to the

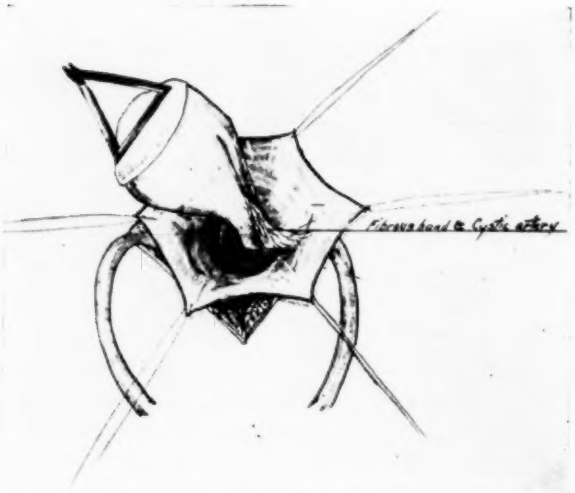

FIG. 1. Subperitoneal resection of gall bladder through incision just large enough to deliver fundus. It is grasped by a triangular-tipped clamp, pulled up, a circular incision made through the peritoneum; and then the peritoneum, retracted by stay sutures, is dissected away from gall bladder to cystic duct. Note strand of fibrous tissue carrying main branch of cystic artery, which is dissected away and tied.*

fundus. A small self-retaining retractor is placed to hold the wound open. With a very sharp knife, and fine, curved, dissecting scissors a circular incision is made just below the clamp through the serosa and subserosa to the muscular wall of the gall bladder. With a suction dissector† the serosa and subserosa are stripped downward and away from the gall bladder wall for about 1 to 2 cm. At this stage a sterile sheet with a small opening is placed over the whole field, with the fundus of the gall bladder protruding through the opening. From six to eight traction sutures are placed through the edge of the dissected peritoneal cuff and tied, leaving one long end which is clamped to the draping sheet. Then with the suction dissector and dissecting scissors the peritoneal coat is peeled off the gall bladder, and the gall bladder is dissected away from the liver bed down to the cystic duct. A long narrow stiff-bladed retractor and a focusing headlight give good vision. As the dissection proceeds, tough strands of tissue will be encountered, running vertically, which bind the serosa to the gall bladder. These strands carry the cystic artery or its branches (see Fig. 1). Generally they can be dissected away from the gall bladder, and clamped and tied if necessary; or a Cushing silver clip can be applied; or the tissue in the strand with the artery can be coagulated by electrosurgery.

As the region of the cystic duct is approached a large strand is encountered, usually on the upper mesial aspect, which contains the main branch of the cystic artery. This should be dissected from the gall bladder high up, secured and cut there. Then it can be readily separated from the gall bladder with the peritoneal coat. As the strand containing the artery is dissected from the cystic duct the folds in the duct straighten and the gall bladder is gradually delivered. The cystic duct is then easily followed to the common duct. A tie is placed about a centimeter from the common duct, and the gall bladder removed. *Care should be taken not to pull up the common duct and tie that.* Blood that flows during dissection is removed by the sucker from the peritoneal sac. Occasionally the cystic artery breaks loose, but the field can be kept clear by the sucker and the vessel clamped, or clipped with a Cushing silver clip. The artery, however, is usually secured higher up and dissected away. A serious hemorrhage has never occurred. This principle of dissecting the cystic artery away from the gall bladder and securing it high up is an excellent one to follow whether doing a cholecystectomy from above downward or from below upward. There is less danger of injury to an abnormally placed hepatic artery or bile duct.

After the gall bladder is removed a medium sized catheter is placed in the peritoneal sac, which is tied around it at the top, moderately tightly with zero plain

* The Author is indebted to Dr. Adrian Solo for the drawing shown herewith.

† This instrument was invented by Dr. Clifford B. Walker for removal of tonsils.

catgut, the traction sutures being cut away. The abdominal wound is closed in the usual manner.

the peritoneal sac. If placed in the sac it is removed after one to three days; if in the duct, after five to seven days.

Fig. 2.

Fig. 3.

Fig. 2. Case 1. Cholecystogram showing a well filled gall bladder with two shadows characteristic of stones.
Fig. 3. Case 1. Gall bladder has contracted markedly after a fat meal, indicating a non-sclerotic wall and a favorable case for subperitoneal cholecystectomy. Instead of two negative shadows representing stones there is one, the other having been due to gas in the colon.

An objection may be made to this technique that it does not allow exploration of the common bile duct. Careful history, laboratory tests and cholecystography should make this unnecessary. If the gall bladder fills and empties fairly well, especially if the patient has not been jaundiced for some time, there is little likelihood of a common-duct stone. But to make sure of this iodized oil can be injected into the cystic duct during the operation and its passage into the duodenum observed by *x*-ray. It must be remembered that instrumental exploration of the common bile duct does not always reveal stones that may be present.[4] In view of this, and the increased trauma, with danger of stenosis, such exploration should be made only under definite indications.

If drainage of the cystic duct is desired the catheter may be fixed in it instead of

A few cases illustrating the application of this method will be presented briefly, the technique being described only in so far as it differs from the description given.

Case 1. A woman of thirty-eight, mother of two children, for four years had suffered repeated attacks of extremely severe pain in the epigastrium and right upper quadrant of the abdomen radiating to the back, associated with belching, and followed by vomiting. She had had jaundice for a short time three years before admission.

Physical and laboratory examinations were negative.

Cholecystograms showed a gall bladder which filled with opaque substance following the combined intravenous and oral method[3] (Fig. 2). A combined examination of the gall bladder, stomach and duodenum was made fluoroscopically and radiographically, the patient being given a fat meal mixed with barium.[3] The stomach and duodenum were negative, no

adhesions being apparent between them and the gall bladder. The vesicle emptied slowly, requiring a second fat meal eight hours after before admission, without other digestive disturbance, or jaundice. Physical and laboratory examinations were negative.

Fig. 4. Fig. 5.

Fig. 4. Case II. Cholecystogram showing clearly outlined shadow of the gall bladder with fine mottling characteristic of stones.

Fig. 5. Case II. Pronounced contraction of gall bladder after a fat meal, evidence that the serosa will strip away readily, a condition essential to subperitoneal cholecystectomy, and the same mottling as in Fig. 4, confirming diagnosis of stones.

the first. Finally the shadow of the vesicle was reduced to a small size and was seen to contain a negative shadow about 1 cm. in diameter representing a stone (Fig. 3). Thus the gall bladder was found to be diseased, though the pronounced contraction indicated a non-sclerotic wall with a serosa which would strip readily.

Cholecystectomy was performed according to the technique previously described. One stone was found 1.5 cm. in diameter; the mucosa was intact, but the wall showed slight evidence of chronic and early acute inflammation.

The drainage tube was removed the first day after the operation; the patient sat up out of bed the sixth day; and went home the eleventh. Fifteen months after the operation she had had no symptoms.

Case II. This patient, a woman of twenty-six, had had several typical attacks of biliary colic following the birth of a child one year

Cholecystograms in this case showed a good gall bladder shadow with definite, constant mottling indicating stones (Fig. 4). There was about 80 per cent decrease in size after a fat meal (Fig. 5). The gall bladder was freely movable under the fluoroscope and simultaneous gastrointestinal examination showed a normal stomach and duodenum, separable from the gall bladder, indicating no adhesions.[3]

Contraction of the gall bladder and absence of adhesions indicated a thin wall with a serosa which would strip readily; the history and gastrointestinal examination indicated no disease outside the gall bladder; consequently this was a suitable case for subperitoneal cholecystectomy.

The operation was performed under novocaine anesthesia, the peritoneum being infiltrated over the vesicle. Traction on the gall bladder produced discomfort, and there was some pain during dissection about the cystic duct, which increased upon clamping the duct.

Numerous small stones were found in the

gall bladder which was thin-walled and the seat of cholesterosis of the mucosa, with mild chronic cholecystitis.

been jaundiced, we felt sure there was no obstruction of the common bile duct. But since it was feared that operative manipulations

Fig. 6. Case iv. A good shadow of the gall bladder containing several negative areas presumably due to stones.

Fig. 7. Case iv. Moderate contraction of gall bladder after a fat meal, delayed twenty-four hours, probably on account of blockage of cystic duct by a stone (arrow).

The catheter was removed the second day after the operation. The patient was out of bed the fifth day, walking about the seventh day, and back at work the fourteenth day. A year after the operation she had had no recurrence of symptoms.

Case iii. This patient, a woman of thirty-two, with no children, had had several attacks of typical biliary colic without jaundice. Cholecystograms showed a contractile gall bladder containing small stones. *X*-ray examination of the gastrointestinal tract was negative. This, then, was a favorable case for subperitoneal cholecystectomy.

The operation, under amytal anesthesia, was carried on as described until the cystic duct was reached. This was found packed with small stones. Since the patient had a gall bladder which filled and emptied, and had never had forced some of the stones into the hepatic duct, the cystic duct was opened, the stones removed or crushed with a small clamp, and a small catheter placed in the cystic duct, being tied with a catgut stitch.

Drainage of bile through the catheter was free for two days, and then stopped. The tube was removed after a week by retracting a little daily.

This patient developed a pain in the right flank with tenderness over the right kidney and pus cells in the urine. Cystoscopy showed a right chronic pyelitis. Three months after the operation she was gaining in weight, without recurrence of biliary symptoms. Discomfort in the right flank was improving, although a moderate amount of pus in the urine persisted.

Case iv. A woman of thirty-five, mother of two children, nine months before admission

began to have soreness in the right upper quadrant of the abdomen, followed after a time by recurrent attacks of severe pain resembling biliary colic. There was no history of jaundice. Her appendix had been removed five years previously.

FIG. 8.

FIG. 9.

FIG. 8. Case VII. Dense shadow of gall bladder with few negative spots at fundus suggesting stones.
FIG. 9. Case VII. Moderate contraction of vesicle, somewhat delayed, with persisting negative shadows at fundus, confirming diagnosis of stones. Contractility of vesicle, with mobility under fluoroscope, indicated that a subperitoneal cholecystectomy could be done. But this was prohibited by conditions shown in Figs. 10 and 11.

Cholecystograms showed a good gall bladder shadow with 5 or 6 negative shadows about 8 mm. in diameter representing stones (Fig. 6). Barium-fat meal (egg yolks and cream mixed with barium)[3] showed normal stomach and duodenum with no adhesions to the gall bladder. The vesicle contracted to about half-size and then stopped for twenty-four hours, probably due to a blocking of the cystic duct with a stone (see Fig. 7).

The contractile non-adherent gall bladder permitted subperitoneal cholecystectomy, performed according to the technique described, the catheter being placed in the peritoneal sac. Five stones 7 to 8 mm. in diameter were found packed into the ampulla of the gall bladder, one of which was blocking the cystic duct.

The gall bladder showed slight cholesterosis and chronic cholecystitis in addition to the five mulberry cholesterol stones.

A small amount of bile drained through the catheter for two days after the operation. The patient had no postoperative distention; she sat up in a chair the seventh day and was walking about the tenth day. Five months after the operation she had been entirely well.

CASE V. A woman of fifty-three, mother of three children, three years before admission began to have a dull pain in the right upper quadrant of the abdomen, radiating to the right scapular region, associated with slight nausea. She had never had jaundice or typical biliary colic, and had had no other digestive disturbance.

Cholecystograms showed a good gall bladder outline with a negative shadow 1.5 cm. in diameter, which was constant on subsequent plates, indicating a stone. The stomach and duodenum were normal by *x*-ray examination. The vesicle contracted very slowly, due presumably to blockage of the duct by the stone. Nevertheless, contraction indicated a serosa which would strip readily.

The gall bladder was removed subperitoneally through a 2 in. incision. The technique differed in only one important particular from that in the other cases. In them silver clips were used to check hemorrhage from the cystic artery and its branches; here the vessel was handled in an entirely different manner. As the serosa was stripped away from the gall bladder from above downward small strands

of fibrous tissue were encountered which contained branches of the cystic artery. These strands were dissected away from the gall bladder as high up as possible, and either broken off or cut. There was little bleeding. Thus by dissecting away the branches of the cystic artery high up and following down close to the gall bladder the artery itself was not encountered, being pushed away with the peritoneal sac.

This patient followed the usual comfortable postoperative course, no nausea or vomiting, no gaseous distention. She walked on the tenth day and was well when seen one month after the operation.

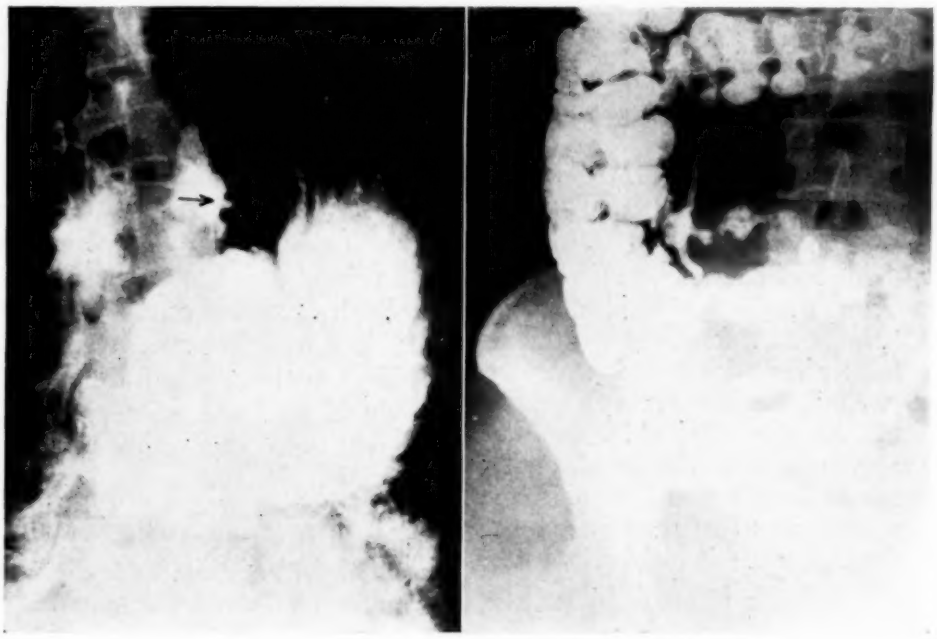

Fig. 10.

Fig. 11.

Fig. 10. Case VII. Radiograph of stomach showing niche typical of duodenal ulcer on anterior wall of duodenal cap (arrow).

Fig. 11. Case VII. Radiograph of colon showing a long, fixed appendix extending from cecum nearly to hepatic flexure.

Case VI. A woman of twenty-two, mother of two children, for three years had had repeated attacks of biliary colic followed by jaundice, the last of which, however, had occurred several months before admission.

Physical and laboratory examinations were negative.

Cholecystograms combined with gastrointestinal series showed a good gall-bladder shadow which contracted readily after a fat meal, with several small constant negative shadows, the alimentary tract being normal.

The gall bladder was removed through a 2 in. incision. Several small stones were found packed into the cystic duct, which was opened, the stones being milked out after dissection of the cystic duct to the common duct. The cystic duct was tied 1 cm. from the common duct, the sac being drained with a catheter. The patient suffered extremely little postoperative discomfort, sat up in bed the fifth day, was out of bed the sixth day, discharged the ninth day, and the fourteenth day came back to the hospital by foot and trolley for examination, which was negative. Two months after the operation she was well.

Case VII is given to illustrate the situation in which subperitoneal cholecystectomy with a small incision should not be done.

A woman of forty-two, mother of four children, three years before admission began to have distress in the right upper quadrant of the abdomen associated with belching of gas, aggravated by greasy foods, and punctuated by attacks of biliary colic, one of which was followed, five months before admission, by jaundice lasting three weeks. There was no hunger-pain; no relief of distress from food or soda; in short no history of peptic ulcer.

Cholecystograms showed a good image of the gall bladder containing several negative shadows 5 mm. in diameter, indicating stones (Fig. 8). After a fat meal the vesicle very slowly contracted to one-fourth its original size, the negative shadows remaining constant (Fig. 9). Contractility to this extent indicated that a subperitoneal resection could be performed. However, following our usual custom, a gastrointestinal series was done. It revealed duodenal ulcer (Fig. 10) and probably a pathological appendix (Fig. 11).

A regular abdominal incision was made, the ulcer resected, a Finney pyloroplasty performed, and the gallbladder removed subperitoneally from above downward according to Doyen's technique. To avoid excessive operative shock the appendix, which was not severely diseased and was difficult of access, was not disturbed. In this case it would have been a grave mistake to have removed the gall bladder through a small incision and left an active duodenal ulcer. The history of jaundice here was also a deterrent, though it need not preclude the operation in question if the jaundice has occurred some time previously, if the gall bladder fills and empties normally, and repeated tests for icterus are negative.

SUMMARY

1. The clinical application of a new method for subperitoneal cholecystectomy is presented, by which the gall bladder is removed from above downward through an abdominal incision just large enough to deliver the fundus.

2. The indications for this technique are (1) a non-sclerotic, non-adherent vesicle from which the serosa will strip readily, and (2) limitation of disease to the gall bladder. These conditions are determined by history, laboratory tests, cholescystography, and gastrointestinal *x*-ray examination.

3. The disadvantages of the method are: a longer operating time, and the necessity for expert dissection and handling of tissues.

4. The advantages of the method are: smaller abdominal incision, with a minimum of reaction and discomfort about the wound and damage to the abdominal wall; diminished shock and trauma to viscera, with lessened postoperative distress, more rapid convalescence, fewer adhesions, and a reduction of operative risk.

NOTE: Since this article was submitted for publication the author has employed the technique described in seven additional cases, with results comparable to those given.

Subserous resection of the gall bladder according to Doyen's technique has been performed by Dr. Egbert L. Mortimer, St. Agnes Hospital, Baltimore, Md. in 50 cases without a fatality. There was a minimum of operative shock, rapid and comfortable recovery without nausea and pain, and excellent late postoperative results. See AM. J. SURG., n. s., 6: 83, 1929.

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TOXINS OF HIGH INTESTINAL OBSTRUCTION*

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THE chemical work which has been reported in connection with the preparation of the toxic material and other constituents derived from the contents of an isolated loop of intestine in dogs is such that no definite conclusions can be drawn. Nesbit[1] was able to isolate choline and another substance, which probably was neurine, from the fluid of an obstructed loop after feeding egg yolk to the dogs. Kukula[2] showed the presence of a diamine, probably cadaverine, in the fluid above an obstruction. These compounds are, however, not toxic enough to account for the usually fatal action of the loop contents. Sweet, Peet, and Hendrix[3] found in the fluid from an occluded loop a proteose and choline-like substance. Gerard[4] suggested that the toxin might be a peptamine containing histamine.

Perhaps the most extensive work on the chemical nature of the toxic material has been carried out by Whipple and his associates.[5] They have been successful in isolating from the contents of an obstructed loop a toxic fraction which they claim is a proteose-like body. Sugito[6] has confirmed the work of Whipple and his associates in many respects. He claims to have been able to obtain the poisonous material in crystalline form with platinum chloride.

We took up the investigation in order to isolate the different constituents present in the contents of an occluded jejunal loop of dogs in the hope of throwing more light on the processes of intestinal obstruction. In preparing the loops we were careful always to take the highest possible segment of jejunum. The loops were washed thoroughly so that all food, worms, and gross foreign material were removed. The ends were inverted with the minimal amount of damage to the mucosa. With these precautions we found that some of the animals would become critically ill and die within forty-eight hours, whereas others would live for six or seven days before showing signs of toxicity. Bacterial cultures were taken from the loops, and there was great variation in the flora of the loops of different dogs. It was our intention to isolate the substance or substances which are mainly responsible for the toxic action of the contents of a closed loop, in a pure crystalline form, in order to find out its chemical composition. In spite of the fact that we have not been successful in this respect we think it worth while, nevertheless, to report briefly our results, especially as our procedure in obtaining the toxic fraction differs somewhat from the method employed by Whipple and his associates.[5] We have also repeated the work of Sugito[6] and shall comment on it later in our paper. Our findings may be of help to those who are still engaged in this field of research.

In following the directions given by Whipple and his co-workers for the isolation of the toxin we found a great disproportion in the yield of toxic material and the toxic strength of a given volume of the loop content. Sometimes we were not able to obtain a toxic material which was soluble in water as stated by Whipple for his product. We found, to our great surprise, that the toxin becomes gradually insoluble in water during the isolation process. It is a well known phenomenon that some water soluble proteins or substances closely related to them gradually become insoluble in water by frequent precipitation with alcohol. Probably we are dealing here with the process of denaturation. We found, however, that the toxin, in-

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soluble in water, is readily soluble in weak alkali, and we therefore employed an alkaline solution in the later stages of the isolation of the toxin. Ingvaldsen, Whipple, Bauman, and Smith[5] stated that alkali was used in order to obtain a clear solution of the toxic substance.

Our procedure in obtaining the toxic fraction may be briefly outlined. The loop content was mixed with twice the amount of 96 per cent alcohol and allowed to stand over night and centrifuged, alcohol solution I, and the precipitate was then extracted three times with 20 c.c. of water in the cold. The aqueous solution, generally not a clear one, was heated to boiling for three minutes. After cooling, the formed precipitate was centrifuged off and extracted twice with 10 c.c. of water. The combined aqueous solutions were evaporated to about 20 c.c. in vacuo and then 150 c.c. of 96 per cent alcohol were added. The precipitate, the formed product of Whipple, was centrifuged off, and washed with alcohol and ether. The alcoholic solution II was combined with the first one. We have found quite frequently that water will extract only very little from the precipitate, but as soon as the solution is made faintly alkaline with sodium carbonate, solution occurs. These alkaline solutions contain the toxin, as has been shown by numerous experiments with dogs. On acidifying the alkaline solution with acetic acid the toxin is thrown out again. The properties of this product agree very well with those stated by Whipple and his co-workers for their product, except the solubility in water. Attempts to purify this product to the crystalline state have so far been without success.

From the alcoholic solutions I and II we were able to isolate cadaverine and histamine in the form of a picrate. Histamine was also detected by its pharmacological properties. Furthermore, we found good evidence for the presence of choline, which was isolated as a mercury chloride salt, and was also demonstrated by its action on the blood pressure before and after injection of atropine. There is no doubt that this alcoholic extract of the loop content also contains basic constituents other than those mentioned. Compounds like histamine and choline might play a rôle in rendering the toxin (albumose) absorbable from the lumen of the intestinal loop. In isolating these substances from the alcoholic solution we employed well known methods, and it would lead too far to give the details here.

We may also mention here that the copper chloride salt isolated by Sugito[6] from the loop content is in all probability choline, as it was found by us to have the typical pharmacological properties of choline or of a compound very closely related to it.

In addition, we would like to comment on some experiments in which the bacterial flora present in the loop were cultivated on broth media from which we isolated, by the method described here, a toxin which seems to have nearly the same properties as the toxin obtained directly from an isolated loop of intestine.

The impression gained by us from our work on the contents of an isolated loop of jejunum in dogs is that it seems that the composition and toxicity of the contents vary widely. Sometimes we had no trouble in obtaining a choline fraction; at other times we could detect only very little. The same was true with cadaverine and histamine. We are also inclined to believe that the chemical composition of the toxin itself varies, depending on the nature of bacteria present in the loop. If this is true, it would be rather difficult to isolate a chemical unity from the loop contents of several obstructed dogs.

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MALIGNANT ADENOMATA OF THE COLON*

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HISTORICAL

THE first mention of a probable case of malignant adenomata of the colon was by Menzel in 1721 in a congenital type of case, in a boy of fifteen years. Wagner reported a case in 1832, Rokitansky reported a case in 1839 of multiple adenomata. The first to describe the polyps themselves was Lebert in 1861, and in the same year Luschka[25] described a case in a female thirty years. Virchow[38] reviewed the cases of Lebert and Luschka, and called the condition, "Colitis polyposis cystica." Von Port collected 14 cases and in 1907 Doering collected 35 cases from the literature. Since that time numerous cases have been reported by the following: Soper,[33] 8 cases in 1916; Struthers,[35] 39 cases in 1920; Struthers,[36] in 1924, 20 cases from the Mayo Clinic, Saint in 1927 in the *British Journal of Surgery* made a very complete and exhaustive study of the condition. Lockhart-Mummery[24] in 1928 contributed to the literature the fact that it was a forerunner to malignancy. Hullsiek[17] 1928 reported a case with a tabulation of the cases up to this time. Since then there have been case reports by Kuhn and Helwig,[20] Tønnesen,[37] and Stewart.[34]

FAMILIAL TENDENCY

Mummery[23] thinks the condition to be a congenital one, as many cases can be traced in the same family, and through several generations. In this case the mother died of an "inoperable" malignancy of the sigmoid. A larger percentage of the patients die in early life and die of malignancy. Cripps saw 3 cases in the same family. Jungling reports 15 cases in three generations, Hullsiek[17] reports a case similar to this one whose brother died of the same condition at the age of thirty-four years; the father died at the age of forty-four of bowel trouble. There are many other reports of similar cases in the same family tree, by Dukes,[10] Jungling,[18] Mummery,[24] Hullsiek,[17] Saint,[32] Tønnesen.[37]

ETIOLOGICAL FACTORS

The etiological factors leading to polypus formation is certainly still in an uncertain state and very little information can be obtained from the literature as to their cause of formation. There are three theories: (1) inflammatory; (2) that concerned with primary epithelial change; and (3) congenital.

The inflammatory theory may be supported by the frequent small, round cell lymphocytic infiltration found on examining the slides, the preponderance of the formation of polyps in the distal colon, sigmoid, and rectum. These segments of the colon are most liable to inflammatory changes. Bardenheuer and Hauser[16] believe the change takes place in the epithelium of normal glands and that the inflammatory changes are secondary in nature. Bardenheuer believes that the development of tumors in places in the bowel most liable to irritation is only significant in their further development.

Another factor in favor of the second theory is that all the mucous membrane in the surrounding tissue of the adenomata examined showed no signs of any inflammatory reaction but was apparently normal. This has also been observed by Quénu,[30–31] Landel, Hauser and Bardenheuer. Undoubtedly they start with a hypertrophy and hyperplasia of the glandular tissue at a certain point, causing a thickening of the mucosa and a small fold. As this increases in size a small pedicle is formed and in due course of time the pedicle becomes elongated. The larger polyps and longer pedicles are only exaggerations of the

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smaller hyperplasia. Histologically they are identically the same. The theory in regard to the increase in size of the polyps still

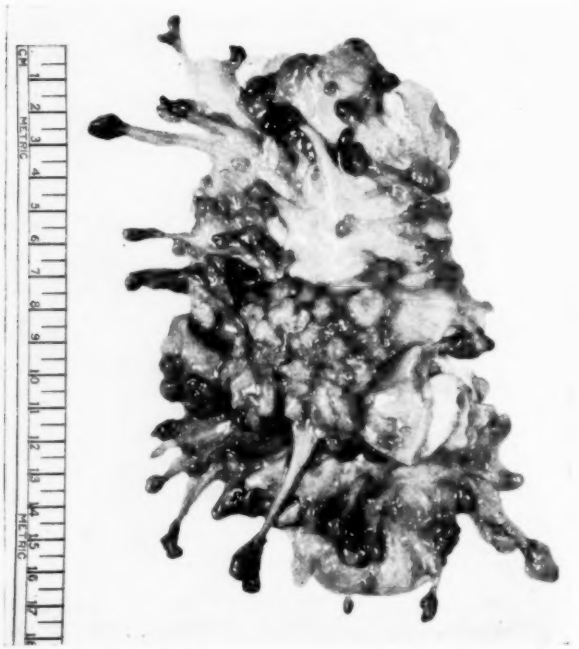

FIG. 1. Area of adenocarcinoma with numerous large and small polyps. Also note length of pedicles.

remains a disputed question. The third theory that they are congenital in origin can be supported by the numerous cases occurring in the same family, but different generations, and cases reported in three generations.

Age: Quénu states that 50 per cent occur between the first and third decades in life, but cases have been reported at almost any age.

Sex: The sex incidence is about equal in different series reported in the literature, 52 per cent in males, and 46 to 47 per cent in females.

Site: The location of the adenomata whether they be single or multiple depends a great deal on the accuracy of the description, and according to Saint[32] they occur as follows: (1) sigmoid; (2) cacum; (3) ascending colon; (4) descending colon and rectum (the last three locations constitute 41 per cent in his series in the large bowel); (5) rectum alone, 24 per cent; (6) colon "unnamed"; (7) transverse colon. In the small bowel they occur most frequently in the ileum, and they are very rarely pedunculated. In the small bowel it is more likely to be a glandular hyperplasia than a true pedicled polyp. Benign polypus growths have been removed surgically from the stomach, and are usually single in this location. Polyps have been of recent years reported in the esophagus, so polyps can occur throughout the entire gastrointestinal tract, but with much greater frequency in the rectum, sigmoid, and the descending colon. The size of the polyps varies considerably as in this case from a simple hyperplasia to a large pedunculated polyp.

Definition: A polyp is a pedunculated or sessile growth which projects into the lumen of the bowel, either as a result of hyperplasia or hypertrophy, of the mucous membrane, or else a benign, true tumor. For clinical purposes an adenoma may be called a glandular tumor, visible to the naked eye, and hyperplasia as a similar change only usually visible by the aid of magnification. Adenomata histologically represent only an advanced stage of hyperplasia.

The intestinal wall is made up of several layers, mucous membrane, submucous layer, unstriped muscle, peritoneal, vascular, and connective tissue, and from these tissues various types of growths may originate and with hypertrophy may project into the lumen of the bowel and form polyps. Therefore one may find such tumors as, fibromata, lipomata, myxomata and hemangiomata, in the lumen of the bowel. The term polyps covers a large variety of tumors unless differentiated histologically.

Polyps in the Large Bowel: Polyps occur much more frequently in the large than in the small bowel. They may be found single, or multiple, throughout the entire gastrointestinal tract. The true adenoma comprises a tumor arising from the glandular epithelium, and it is the most frequent type of polyp which occurs in the bowel. The polyps vary considerably in size from a pinpoint to some as large as 5 and 6 cm. in diameter. If of a large type they are

usually single, but there may be many smaller ones also in the bowel. Multiple adenomata may either cover the mucous membrane of the entire colon or else be thickly "studded" and confined to one segment of the bowel. There have been numerous names applied to this condition, multiple polyposis, colitis polyposis, colitis polyposa cystica.

In most of the cases the histological study shows a dilatation of the glands into cyst-like spaces. This cyst-like appearance is undoubtedly caused by an obliteration of the mouths of the secreting glands, during the inflammatory stage.

In a second type of ademomata the mucous membrane has only a few polyps and they are usually pedunculated. They are usually much larger than in the other group and more likely to undergo malignant changes. In the case I am reporting, the pedicles varied from a hyperplasia to 5 and 6 cm. in length (see Fig. 1). The polyp is a shade darker than the pedicle and mucous membrane. The adenomata vary in color from a bright red, to black, many are grayish white, being covered with a thick mucous secretion. The pedicle is smooth and covered with mucous membrane, which is continuous with that of the bowel. The pedicle at its base is usually rounded, but as it reaches the end it has a tendency to become flattened out. The pedicles in the rectum are more likely to be flattened than higher up in the colon. The polyps are granular in appearance, bleed easily, many of them are smooth, depending on the amount of irritation. Some have a tendency to be lobulated. The polyps in this case in the splenic and transverse colon are smooth; in the sigmoid they are granular, lobulated, and bright red in color. This I think is due to the fact that the polyps in the sigmoid are much larger than they are in the transverse colon. The pedicle consists of connective tissue, mucous membrane and a few smooth muscle fibers, and capillaries.

The tumor part of the polyp consists histologically of glandular and connective tissue elements. The glands are mostly tubular in type and open on the surface; however, in many, the mouth of the

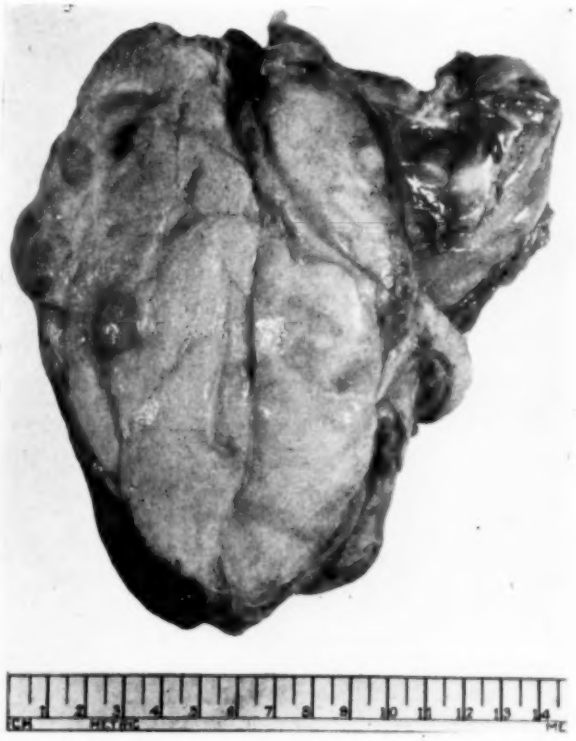

Fig. 2. Infiltrating tumor mass into anterior abdominal wall.

gland is closed, and the glands take on a cyst appearance. The glands are lined with a columnar epithelium and those near the base represent the glands of the mucous membrane of the bowel. The blood vessels are capillary in type, and contain a few red blood cells. In several areas there are numerous round cell lymphocytic infiltrations. The tumor portion is very loosely attached to the pedicle and is very easily detached on cleansing the bowel under running water.

The pedicle originates in the submucosa and extends upward into the tumor proper. The muscular fibers originate in the muscular layer and extend upward into the pedicle subjacent to the mucous layer and as they come closer to the tumor portion they disappear.

As the adenomatous tumors increase in size they undergo changes of clinical and histological importance, as far as the treatment is concerned.

The pedunculated tumors vary in size from a pinpoint to 3 and 4 cm. in diameter. They also vary in color and consistency

Fig. 3. Tumor mass in anterior abdominal wall replacing rectus muscle.

according to location, and the amount of irritation present. The polyp is usually covered with a thick tenecious mucous secretion, and there is a large amount of mucous secretion throughout the large bowel (Figs. 1 and 4).

POLYPS AND THEIR RELATION TO MALIGNANCY

As the adenomata increase in size there is a tendency for them to become less differentiated, and it may be extremely difficult to say whether they are malignant. Cells which serve no useful physiological function except with the embryonic function of the cell proliferation, present an important question as regards their surgical treatment.

In looking for malignant changes one must search the periphery of the larger polyps, as it is here that carcinomatous changes are most likely to occur. The frequency of multiple polyposis and malignant degeneration in the literature has led surgeons and pathologists to the opinion that adenomata are capable of undergoing malignant changes. This opinion rests mostly on clinical rather than histological basis. Mummery states that whether of the single or multiple variety they show a marked tendency sooner or later to become malignant. The case here reported proves the statement.

Some writers take the opinion that single or multiple polyps are only a state of malignancy or a precancerous condition. If this be the case then we are presented with a difficult surgical problem. If with satisfactory evidence that the polyp is single and of the large variety, it can be removed surgically by opening the bowel under aseptic precautions, with cauterization or fulguration of the base, and closure. However, if there are multiple polyps extending throughout the large colon, as in this case, a more radical operation is required, and very little less than a colectomy will bring the desired results. A segmental resection, Mikulicz, and an ileocolostomy, Kraske, etc., are only in part fulfilling the required demands for relief as far as a cure is concerned. Whatever surgical procedure is carried out has a high mortality even under the best surgical treatment. To do a colectomy leaves the patient practically an invalid even if he survives the operation.

If a Mikulicz type of resection be done, one is likely to transplant some of the friable polypus tissue into the abdominal wall and the secondary growth will be disseminated throughout the abdominal wall as in this case (Figs. 2 and 3). In this case the polyps were multiple and malignant. This type of case is very rare in the literature, as most of the malignant polyps are large and single. One of the reasons given why multiple polyps do not

become malignant is that they never become large enough to undergo malignant change. The adenomata that undergo malignant change are usually 3 or more cm. in diameter. Saint reports a series of 36 cases with malignant changes in 13 per cent. The occurrence of malignancy and multiple polyps are rather rare in the same colon considering the frequency of malignancy in the large bowel.

Treatment: The only treatment of any value is surgery, and as stated previously in this article the surgical procedures are major ones, and carry a very high mortality for the beneficial effect obtained. Deep *x*-ray has practically little or no value in this type of lesion as shown in this case, the one of Hullsiek, and many others.

In summing up the treatment Erdman[12] has said the following:

> One may sum up the present status of treatment of such a condition by saying, that the only method which holds out any hope for cure in the disseminated variety is one imposing upon the operator great technical difficulties, upon the patient great danger, and upon both the possibility that a successful operation may prove fruitless because the operator has been unable to determine accurately the extent of the growths and has therefore left behind areas capable of transmitting all the original potentialities of the disease.

CASE REPORT

H. G. M. Male, aged thirty-two, salesman.

Family History: father died, aged twenty-nine, of pneumonia. Mother died, aged forty-two, malignancy of colon. Brother one, twenty-seven, living and fair health.

Past History: measles and mumps as a child.

Operations: 1. Hemorrhoidectomy, 1918, for bleeding hemorrhoids. 2. Injected hemorrhoids 1920 for bleeding. 3. Lipoma from the back, removed in 1918. 4. Resection of colon 1925, for multiple polyposes.

Chief Complaint: Weakness, anemia, feeling tired, passing of blood by rectum. For some time prior to operation in 1925, patient would at intermittent intervals pass a small amount of blood when the bowels would act. On different occasions the stools would be dark in color. This kept up over a period of several years, was told that it was caused by bleeding hemorrhoids, and had a hemorrhoidectomy. This did not stop the bleeding. Was told that

Fig. 4. Polyps extending as far as hepatic flexure of large bowel, with long and short pedicles. Grayish white areas represent mucous secretion. Note abnormal length of appendix.

the internal hemorrhoids still caused the trouble and needed them injected. This was done, but the bleeding still continued in small, irregular amounts. He passed large amount of mucus. Bowels fairly regular as he watched his diet and habits. Eats everything, no gas, burning, gnawing, etc.

Genitourinary: essentially negative. *Cardio-respiratory:* No cough, colds, edema, or cyanosis, etc. *Examination:* Fairly well developed male, appearance of a mild secondary anemia. Pupils round, regular, react to light and accomodation. Teeth excellent, Tonsils, small fibrous, no infection. Neck, essentially negative. Chest, apex normal position, loud, clear, no murmurs. Other heart sounds the same. Lungs apparently negative. Abdomen, no tumor masses, rigidity, etc. Rectal, external negative.

Internal palpation. Could not feel any induration or tumor masses. Temperature. 98.4°F. Pulse 78. Respiration 18. Blood pressure

Fig. 5. Tumor mass infiltrating inferior vena cava. A. Tumor mass. B. Liver.

120/84. Urine essentially negative. Blood, Hemoglobin, 60. Red blood count 3,200,000. White blood count 5200. Wassermann test negative. *X*-ray chest negative. Stool examination shows positive benzedine for blood. *Proctoscopic Examination:* The mucous membrane appears injected in places, with numerous polyps some with rather long pedicles, others a hyperplasia of the epithelium. At the distal point of the sigmoidscope a tumor mass consisting of numerous polyps can be seen, and these bleed very easily. Evidence of old scar from hemorrhoidectomy. *X*-ray of colon shows a filling defect in the sigmoid colon. *Diagnosis:* Multiple bleeding polyps in the sigmoid. Secondary anemia. October, 1925, a Mickulicz resection, following a midline exploration. The second stage of the operation 10 cm. of sigmoid were resected, and the pathological diagnosis was adenocarcinoma with no glandular involvement. Patient made an uneventful convalescence but it was impossible to get the colostomy closed and he always had a small fecal fistula. Following this operation in December 1925 and January 1926 he had deep *x*-ray therapy in all directions. Again in June of 1926 he had deep *x*-ray, and *x*-ray again in May 1927, and last again in February 1928. From all clinical evidence the deep therapy had very little results, as a recurrence began to show up in abdominal wall in March 1927 and continued to increase in size, until the time of death. This hard, smooth mass was confined to the anterior abdominal wall. Following the operation he was given oil enemas, yeast, iodine, kaolin, salol, and many other so-called bowel antiseptics without any beneficial effect.

He gradually became weaker and was practically helpless in December 1927 although he did not enter the hospital until June 1928, and died December 6, 1928.

Autopsy: Died Dec. 6, 1928, 9:30 A.M. H. G. M. autopsy by E. M. Hall, pathologist St. Vincent's Hospital. Male. Aged thirty-two, single. Salesman. Length, 5 ft. 8 in. edema III of the thighs, genitalia, abdomen, chest up to a level of the third rib and the forearms. Emaciation III. Eyes sunken. Pupils dilated round, regular.

Half the distance between the symphsis and the umbilicus there is a colostomy opening measuring 6 × 4 cm. and deep enough to lose a hemostatic forceps. On looking into the colostomy opening one sees a granular appearance, grayish white in color and studded with polyp-like tissue. The colostomy is surrounded by a board-like hardness which is fixed in the abdominal wall. The lower one-half of the abdomen is also infiltrated with this board-like hardness and it extends laterally to the anterior superior spine of the ilium. On cutting through the abdominal wall the infiltrating tissue measures 10 cm. in thickness on the left side of the colostomy, and 5 to 6 cm. on the right side of the colostomy (see Fig. 2).

The colon extending into the colostomy is infiltrated and surrounded with malignant tissue. The portion of the sigmoid above the

colostomy for 15 cm. is involved along the mesenteric attachments.

The stomach is dilated and contains 300 c.c. of foul smelling, dark colored liquid material. On opening the stomach the mucous membrane is pale, and somewhat edematous. There is no break in the mucous membrane.

Duodenum: No ulcerations or scars. Apparently negative. The rest of the small bowel and mucous membrane is pale, and in places there appears to be areas of hyperplasia. Throughout the small bowel there is a thick, tenacious material light yellow in color, and it is easily removed by washing under the tap. Appears to be bile-stained mucus. The cecum is dilated and freely movable. The appendix measures 23 cm. in length, is free and shows no evidence of any adhesions. It has a long free mesentery (see Fig. 4).

The ascending colon as far as the hepatic flexure appears normal, except for an edematous appearance, beginning in the middle third of the transverse colon (see Fig. 4). There are numerous polyps, both with and without a pedicle.

As one goes to the splenic flexure, descending colon and sigmoid the polyps increase in size and number, and on palpating the wall of the bowel there is a feeling of resistance that is not in the wall of the bowel where the polyps are not so numerous. Throughout the colon there are numerous areas of hyperplasia of the epithelium, and these are more abundant in the distal descending colon, and sigmoid (see Fig. 4). The sigmoid colon was deflected in the right lower quadrant following the operation, by the extrinsic pressure of the tumor mass in the abdominal wall.

The mucous membrane of the rectum is very edematous, and injected with many small polyps, also some areas that appear to be scars from cauterization. No ulcerations. The sigmoid is one solid mass of polyps varying in size from a pinhead to the size of a large hazel nut (Fig. 1). Some of the polyps have pedicles that measure from 2 cm. to 5 to 6 cm. in length (see Fig. 1). There is a solid polypous mass in the sigmoid measuring 4×5 cm. which has the appearance of carcinoma (Fig. 1). This polypous area was attached to the anterior abdominal wall at the site of the colostomy. The polyps vary in color from a bright red to a black and gray. There are no lymph nodes involved that we are able to make out.

Pleural cavities contained about 1200 c.c. of light straw colored fluid. There are no pleural adhesions and no scars at the apex. No calcified lymph nodes at the hilus of either lung. The lungs are almost completely collapsed.

The heat weighs 200 gm. Small valves appear normal, no sclerosis, or vegetations. Chambers normal. Musculature dark red, and firm. Coronary arteries apparently normal. Aorta normal.

Spleen: Weight 80 gm. Small, firm, dark red in color, and resists section. On cut section the trabeculae are prominent, also the Malpighian bodies. Adrenal: Apparently normal.

Kidneys: Right 100 gm. capsule strips easily, light gray color, pyramids prominent. Pelvis appears to be normal. Left, weighs 125 gm. Otherwise the same.

Pancreas weighs 200 gm. firm, nodular, no tumor masses. No adhesions.

Liver weighs 1500 gm., surfaces smooth, light red in color, no tumor masses. On cut section light yellow in color, showing fat replacement of liver tissue. The edges are sharp, fibrous tissue prominent.

The gall bladder is distended with a thick, greenish, black bile, no stones. About 10 c.c. of bile. The mucous membrane of the gall bladder appears thickened, otherwise normal. Gall-bladder ducts patent, no stones.

The inferior vana cava extending from the union of the iliacs to where it joins the liver is filled with a hard, light, yellow growth which is very adherent to the wall of the veins. This growth extends up to a point where the vein enters the liver (Fig. 5). There is also tumor tissue extending into the common iliac veins and from other small veins which join the inferior vena cava.

The prostate is small and firm, and is not involved in the tumor mass. The urinary bladder is small. The mucous membrane is very edematous and injected showing evidence of inflammation, particularly about the trigone. The tumor mass surrounds the bladder, has invaded under the symphysis and into the space of Retzius. Also has spread into the lateral walls of the pelvis into the muscular tissue. There are no diverticula in the urinary bladder. The tumor mass in the pelvis is of the same hardness as that in the abdominal wall.

CONCLUSION

1. An unusual case in which multiple adenomata of the large and small variety

have undergone malignant changes is reported. The polyps vary in size from a simple hyperplasia to 5 and 6 cm. in diameter, and with pedicles up to 6 cm. in length.

2. Recurrence occurred at the site of the old operation, and about the colostomy opening, as a result of transplanted tissue from the Mickulicz resection and not removing enough of the colon.

3. Adenomata in the colon and secondary implants in the abdominal wall are very resistant to deep *x*-ray therapy.

4. In a very large percentage all single adenomata are malignant, while in the multiple type they may become malignant, if they increase in size, sufficient to undergo malignant changes.

5. Adenomata occur most frequently in the large bowel; they occasionally occur in the small bowel, and may occur throughout the gastrointestinal tract.

6. All adenomata are potentially malignant and the type of operation, and postoperative treatment should be left to the surgeon, and individual case.

7. Malignant changes begin in the periphery of the larger polyps and rarely occur in the smaller ones.

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[For Remainder of References see p. 272.]

INTERDUODENAL FISTULA*

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AN acute perforated peptic ulcer, in the great majority of cases, requires early surgical attention or diffuse peritonitis will result with a fatal termination.

In an occasional case the perforation will become plugged with a piece of omentum or some adjoining organ such as the liver, gall bladder or intestine. The opening may become sealed, and recovery take place, or the perforation may extend into the contiguous organ with varying effects, depending upon the viscus involved. If the viscus be the stomach or intestine, a fistulous tract may become established, which may persist for an indefinite length of time. Cases of this kind are rare and consequently of interest. In the following case a fistula was discovered leading from the first portion of the duodenum to the third portion, producing an interduodenal fistula.

REPORT OF A CASE

History: Mr. J. I., aged forty, was referred by Dr. John Ruddock for a surgical opinion in March, 1928. The patient complained of attacks of pain in his upper right abdomen. These attacks began shortly after a right nephrectomy four years prior to admission. This operation was done for a calculus pyonephrosis, and was performed with great difficulty. The pain was described as being severe, appearing suddenly, and of indefinite duration. It was usually worse at night. It had no relation to meals, although at times it was relieved by a large amount of food. The patient had nausea but no vomiting. No blood was noticed in the stools. There was moderate loss of weight. The attacks gradually became worse, until he was unable to attend to his work.

He was observed and treated by a number of doctors but obtained no relief. In June, 1927, his abdomen was explored and a chronically inflamed appendix was removed. The attacks of pain persisted unchanged and no definite diagnosis could be established.

The past history was clear except for a left nephrotomy for renal calculae in 1917.

Examination: Examination revealed a muscular individual with a normal blood pressure, pulse, and temperature. The abdomen showed a long right rectus scar and there was moderate tenderness in the upper right quadrant. There were operative scars in both lumbar spaces. The remainder of the examination was essentially negative. The blood count, urine, blood Wassermann test and stool were negative.

The radiological studies by Dr. Davis solved the problem. A summary of his findings showed a constant deformity of the duodenal cap on the lesser curvature side. In addition there was either an accessory loop of bowel, a fistula, or a penetrating ulcer, extending from the first portion of the duodenum to the third portion.

On the basis of these studies an operation was advised which was performed by Dr. C. G. Toland.

Operation: The stomach and duodenum were exposed through an upper right rectus incision. There were many adhesions and marked induration about the pylorus. A fistula was discovered about ½ in. distal to the pyloric ring, which led downward and into the third portion of the duodenum. This tract was shaped like an inverted cone and was composed of scar tissue. It evidently was the result of an ulcer which had perforated from the first to the third portion of the duodenum.

The fistula was excised and the two openings in the duodenum were closed. There was considerable narrowing of the duodenum, so a posterior gastroenterostomy was deemed advisable. The wound was closed to a Penrose drain.

Aside from a moderate postoperative bronchitis, the convalescence was fairly smooth. The patient was discharged in about three weeks.

In March 1929, one year later, he had gained 30 lb. and had no gastric symptoms. He had some pain in his lower right abdomen so radiological studies were advised.

* Read before the Los Angeles Surgical Society, October 10, 1930.

Dr. Davis found the gastroenterostomy to be freely patent with the majority of barium going through it. There was a deformity of the duodenum which may have been produced by postoperative adhesions. The barium enema showed some angulation of the cecum probably caused by adhesions.

The patient was observed one month later and stated he was free from symptoms.

FIG. 1. Before operation showing interduodenal fistula.

FIG. 2. One year after operation showing functioning gastroenterostomy and narrowed duodenum.

COMMENT

Cases of interduodenal fistula undoubtedly occasionally occur, although there have been no cases reported in the recent literature. A few cases of fistula between the duodenum and the gall bladder or into the stomach are on record.

The most likely explanation for the condition in this case is that an ulcer had perforated slowly from the first to the third portion of the duodenum producing the fistula.

It is possible that the posterior wall of the duodenum could have been injured during the nephrectomy and such a fistula occur, although a direct external fistula usually results following such an accident.

DISCUSSION

DR. O. O. WITHERBEE: Various explanations concerning the process of development in this case might be advanced but when we remember the frequency with which the first portion of the duodenum is involved, compared with the third portion, it seems quite obvious that perforation must first have occurred at the higher level and the escaping contents, assisted by gravity, made their way downward, to be followed by ulceration and entrance into the bowel at this lower point.

It is well known that the intestine is prone, by a process of ulceration, to take into its lumen and eventually discharge foreign substances which have found their way into the abdominal cavity.

Some years ago a patient at the General Hospital discharged a mass of gauze as large as one's fist, that had been left in the abdominal cavity at a previous operation. This occurred without any evidence of peritonitis and with no special discomfort to the patient, excepting that occasioned by dilatation of the sphincter muscle.

HOUSTON VALVES

THEIR RÔLE AS A FACTOR IN RECTAL OBSTIPATION, PELVIC AND OTHER DYSFUNCTIONS*

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THE Houston valves were first described by John Houston[1] of Dublin. These valves are usually three in number, though four, five or more have been reported. They are arranged spirally, at different levels, about ½ in. apart, the end of one overlapping the beginning of the other. The first or lowermost is found about 3 in. above the anal border, the others from ¼ to ¾ in. apart, and the uppermost just below and being a landmark for the entrance to the rectosigmoidal junction. Each occupies about one-third of the circumference of the wall, normally is ¼ to ½ in. in width from its attachment to the free border, and should present a good-sized opening between the free border of the valves.

Each valve is covered by mucous membrane, between which layers are found connective tissue, fat, muscle fibers, blood vessels, and some nerves.

Following Houston's description, Nélaton described a third sphincter muscle, with which Velpeau (1837), Gosselin, Kohlrausch (1854), Hyrtl (1857), Henle (1873), apparently agreed. O'Beirne (1833), Busche (1837), Bodenhamer (1870), absolutely denied the existence of these valves. Chadwich (1878) and Dr. Walter J. Otis (1887), American investigators, corroborate Houston's description and deny the third sphincter muscle theory.

The latter was probably the first to use atmospheric distention for the study of these valves, placing the patient in the knee-chest position and using retractors to hold the rectum open. This, Charles Martin, formerly of Columbus, Ohio, now of Washington, D.C., third president of the American Proctologic Society, described, using atmospheric inflation for satisfactorily viewing these semilunar valves in the July and October numbers of *Mathews' Medical Quarterly* 1896. In 1899, before the American Medical Association, he read a paper entitled, "Phantom, Semi-lunar and Annular Strictures of the Rectum. Their Diagnosis and Radical Treatment under Direct Inspection."[2] And to Dr. Martin belongs the credit of reviving interest in the description of Houston's valves, but particularly is he entitled to describing and performing the first valvotomy. The existence of these valves were again vigorously denied by Bodenhamer.[3] Dr. Joseph Mathews, deceased, the first president of the American Proctologic Society, very positively denies the existence of these valves.[4] Otis, Martin, Pennington and Gant's observations agree with Houston in the main, and it is very probable that Nélaton, Hyrtl, Kohlrausch and Velpeau saw and described but one and the most prominent valve as the third sphincter.

Diagnosis: For viewing normal or diagnosing hypertrophied valves, one must have (a) the patient in the proper position, either the knee-chest or the Hayne's position, (b) a proper instrument, preferably a 10 in. proctoscope, and (c) a reflected light, or an electrically lighted proctoscope. Air insufflation in the Sims' position, does not permit of the proper viewing obtained by proctoscopic examination as in either of the inverted positions mentioned.

Function: The original theory that these valves were intended to support the fecal mass has been discarded, and their function to prevent the sudden deposit of the emptying sigmoid into the ampulla is accepted. Thus the physiological function may be-

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come pathological when hypertrophy prevents the passage of the fecal mass through the rectum.

Symptoms: The appended symptomatology was noted in over 200 cases examined, and 150 patients were operated on.

	Cases
Constipation	182
Bladder trouble	3
Neuritis or rheumatism	11
Pruritis	20
Dermatosis	3
Backache	21
Feeling not empty	15
Nervousness	20
Colitis, blood, mucous	8
Hemorrhoids / Protrusion, bleeding	45
Gas in bowels	30
Epilepsy	2
Stomach, indigestion	30
Papillae, crypts	7
Fissure	13
Loss of weight / Faintness, malaise	12
Prostate trouble	2

Age of patients—Years

	Cases
5 to 10	3
10 to 25	22
25 to 35	105
45 to 55	40
55 to 65	16
65 to 75	4

Sex—

Male	96
Female	127

Duration of symptoms—

All their life	40
1 to 5 years	90
5 to 10 years	15
10 to 20 years	9

Difficulty in expelling enema, noted frequently. No constipation, recognized as such by patient, but two, three or more evacuations daily noted in 18 cases, in which proctoscope showed persistent retention.

Purplish, mottled, mucous membrane (hemachromatosis) above and around Houston valves noted in 5 cases.

Pathology: The usual interpretation of hypertrophy, thickening, was much less frequently found than the thin wide valves, this increase in width obstructing the lumen or causing an overlapping of the free edges. No ulcers were seen, but varying degrees of inflammation of the mucosa (proctitis) was observed in practically all cases. Recurrence of hemorrhoids, surgically removed, where hypertrophied valves with fecal retention were originally present, was encountered in 2 cases. The positions of the various valves were by no means constant. The positions in the same patient have been found changed from day to day, and a complete change of position has been observed during the course of examination. The positions observed follow—

	Cases
Transverse	29
No. 2 on right	53
2 on left	60
1 on right	62
1 on left	46
3	25
4	1
5	1

Number of valves causing obstruction—

1	22
2	89
3	22

Treatment: Hypertrophy, in either thickness or width causing persistent fecal retention, was considered necessarily operative. A patient having hypertrophy without retention was not operated on or considered an operative case. Twenty-four cases were treated by massage digitally or massage with the proctoscope, and sphincters thoroughly dilated till a No. 4 Pratt's dilator entered easily. Local applications of saturated solution of magnesium sulphate, adrenalin or both, were applied locally. Five of these patients improved temporarily, i.e., the upper rectum was found empty on proctoscopic examination. In a few weeks or months the former condition of retention recurred. This condition is therefore considered permanently curable only by surgery.

Operation: Martin's original operation consisted of catching the valve with hooks, used through his 6 in. rectoscope, incising the valve to the muscle, suturing with a special long needle holder, and packing the incisions and rectum tightly with gauze to control hemorrhage, the gauze being removed in twenty-four hours.[5] This operation was not attempted in this series.

Operations: In this series were performed in the Hayne's position, under novocaine 1 per cent perianal, 30 to 40 c.c., combined with sacral 1 per cent novocaine 30 c.c., or spinal anesthesia 100 mg. novocaine. Preoperative opiates were used in nervous patients. Originally the first operations consisted of excision of a U or V shaped sections, such openings as would be obtained by the use of the clips used by Gant and Pennington. These excisions were made with knife, scissors or diathermy bipolar current. Incisions were sutured except when diathermy used. In all operations the necessary exposure was obtained with a Sim's retractor, the valve grasped with an Allis forceps and brought to the anal opening. Hirschman's rubber ligature was used in 6 cases, or a section of the valve was excised parallel to the free border, sutured with a continuous Lembert catgut, leaving approximately a normal width valve. All of these methods were found defective. The U and V incisions filled from the bottom of the cuts, nearly to the top; rubber ligature method, same fault. The parallel excisions caused rigidity in the cut valve or valves and an altered topography causing obstruction in the remaining valve. The final operative technique evolved, producing uniformly good results, consists of grasping the valve at the point to be incised and drawing it out to the anal border. Two straight forceps are then applied V shaped, with the tips of the forceps close to the valve attachment at the rectal wall; the distance across the base of the inverted V, between the forceps being about 1½ to 2 in. The Allis forceps are then removed, the valve held taut by the two straight forceps, the incision made with scissors from the point where the Allis forceps were applied to near the apex of the V. The excess of valve parallel to the forceps is trimmed away, leaving a small margin through which the No. 2 catgut chromic, interrupted sutures are placed; three or four on each side and one at the apex. Complete hemostasis is obtained; the forceps released, the valve springs back to its original position. The same technique is used on the other involved valves. Operative time is ten minutes to each valve. The opening consists finally of two or more V shaped apertures with the bases opposed, and a valve of normal width remaining. Operative sites are mopped with 20 per cent mercurochrome, and the patient returned to bed without packing or dressings. Bowels opened on the third day, and the patient up and ready to leave the hospital on that day or the next. There is no postoperative pain, because the operative site is above the painful nerve supply.

The Postoperative Results: In all cases uncomplicated by gall bladder or appendix pathology were uniformly good. No catharsis or enema was required. One case in which a gastrointestinal series showed small and large intestinal stasis, patient sixty-three years old, was unimproved one year after operation. Fecal retention of ten to twenty-five years' duration in old people with atonic colons, responded slowly, but in none was catharsis or enema persistently necessary. Some form of mineral oil only was used in all cases for a varying length of time. Re-operated cases were those in which the original operative technique, clip or parallel excisions or rubber ligature were used.

Results obtained:

	Cases
Cured	54
Improved	71
Same after treatment	19
Died	2
Recurrence	4
Treated; not surgery	24
Observed; no treatment	52

The relatively large number improved over cured is due to a large number being Los Angeles General Hospital Clinic cases, and impossible to adequately follow-up.

Conclusions: In spite of adverse criticism regarding the operation or vigorous negation of their existence, it is felt that with the patient in the proper position and a properly lighted instrument used, no difficulty should be encountered in the diagnosis. The operation properly performed does

not alter the architecture of the rectum,[6] except in a beneficial way. This being a drainage operation any pathology arising as a result of the rectum becoming a focus of infection, makes valvotomy a necessity.

Two or more evacuations daily usually denote an obstipation, rather than a normal condition, and as Gant has so properly said:

> In persons suffering from chronic constipation it is unwise to venture an opinion as to the cause or causes of the trouble until the anus and the surrounding parts have been carefully inspected and palpated, a digital examination of the lower bowel has been made, the rectum and sigmoid have been thoroughly inspected through the proctoscope and sigmoidoscope.

Regarding the 2 cases of epilepsy, mentioned:

Case I. Epileptic attacks irregular, about 3 or 4 a year from birth. Valvotomy Dec. 8, 1927. Attack occurred in Oct. 1928, following dietary indiscretion and consequent constipation. Patient's mother reported this as a very mild attack. No attacks since to date.

Case II. Epileptic attacks about every six weeks; duration nine years, following constipation requiring catharsis or enema daily. No attack since valvotomy July 9, 1929. Last attacks about June 25, 1929. This patient empties completely with one natural defecation daily. No cathartic or enema used since operation, but it is much too soon to expect result as to epilepsy.

One case, a female aged eighty-three years, died five days postoperative, in the Los Angeles General Hospital. No autopsy; no immediate cause of death discoverable. The second patient died of pneumonia, following a prostatectomy done under spinal anesthesia, two weeks after a valvotomy. If it is carefully done, there is no reason why the peritoneum should be opened; therefore no deaths should result. The technique of bringing the valves out to the anal opening makes valvotomy nearly as easy as a hemorrhoidectomy, which the motion picture should demonstrate.

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CONGENITAL ABSENCE OF THE APPENDIX VERMIFORMIS*

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CONGENITAL absence of an appendix is a very rare anomaly. The first one who described this was Morgagni[1] in 1719. It was next reported by Hunter[2] in 1762 and by Haller[3] in 1765. Eleven cases were reported in the nineteenth century and 23 in the twentieth century up to 1925, when Dorland[4] wrote his excellent monograph on this rare anomaly. Since that time 7 other cases have been added; 3 were mentioned prior to the report of Dorland (one by Bloodgood[5] in 1915, another by Swan[6] from a personal communication from Guiteras in 1898, and the third by Marie[7] in 1903) but were not included in his collection of cases; 1 case was described by Maurer,[8] 1 by Bradley,[9] and the sixth case was related to me by Dorland as having been seen by Sir W. Blair Bell of Liverpool, England, and 1 by Jacobs.[10] This makes a total of 44 cases and my cases are the forty-fifth and forty-sixth.

Of these cases, 9 were discovered at autopsy and 6 on the dissecting table; 4 are museum specimens, and the rest were found at operation. Some of these cases are not really true agenesis but are rather types of hypoplasia: In the case of Marshall and Edwards[11] there was an elevation of 2 mm. at the junction of the tenia coli and a depression on the inner side.

In the case of Bradley[9] there was an elevation of 3 mm. These are therefore cases of hypoplasia. If we exclude these cases and also the ones where the diagnosis was made on the operating table in which the results might be questionable or where the appendix was not found but in which there were adhesions around the cecum, then the cases of actual agenesis of the appendix can be cut nearly to half. Indeed, probably it would be closer to the truth to say that only about 25 cases were undoubtedly true agenesis.

Our cases present some interesting features aside from their rarity. One specimen belongs to a male cadaver; the age of this male was about fifty years. The abdominal wall had no scars from previous operations: the abdominal cavity was glistening and there were no adhesions whatever. The terminal part of the ileum could not be brought outside the abdominal cavity. It was resting in a flattened position on the m. psoas major covered by the peritoneum. The peritoneum was smooth and shining. The cecum was smooth and shining and the lower part of it was moderately movable. The appendix could not be located. We followed the tenia which were arranged in the following way: The tenia coli anterior subdivided in two parts; one continued its course and the other turned in a semicircular manner to the medial anterior border of the cecum and joined the medial tenia which had a normal course. The posterior tenia sloped downwards and gave out one branch which turned medially and fused with the medial branch of the anterior tenia. Nothing was found at the place of junction of the tenia.

In order to ascertain whether we were dealing with a retrocecal appendix which did not take its origin right at the junction of the tenia, we made an incision through the peritoneum on the lateral side of the colon ascendens and cecum, exactly in the same manner as one employs for the mobilization of the duodenum by Kocher's method. After the peritoneum was incised, the finger was inserted behind the inner lip of the peritoneum and the cecum lifted. The posterior surface of the cecum and colon ascendens was turned anteriorly and was carefully palpated. No cord or anything resembling an appendix could be located. *Indeed, we believe that in the*

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operating room when one is unable to locate the appendix in the usual way, one should expose the posterior surface of the cecum by the manipulation mentioned here. Failing to find any traces of the appendix, we mobilized the terminal part of the ileum by incising the peritoneal fold just across the m. psoas major and by inserting the finger and lifting the ileum. Occasionally we found in cases of retrocecal appendix, that the terminal part of the ileum is bound down to the m. psoas major by a peritoneal fold. *It might be of some use as a guide to a surgeon to know that the freely movable terminal part of the ileum does not necessarily mean that there is not a retrocecal appendix, but a terminal part of ileum bound down by peritoneal folds to the m. psoas does suggest a retrocecal appendix.* When the ileum was raised, part of the peritoneum released from the psoas major was hanging from the ileum and a small piece from the cecum. It was thin and translucent, so that it was obvious that this band was not the appendix.

Fig. 1.

Fig. 2.

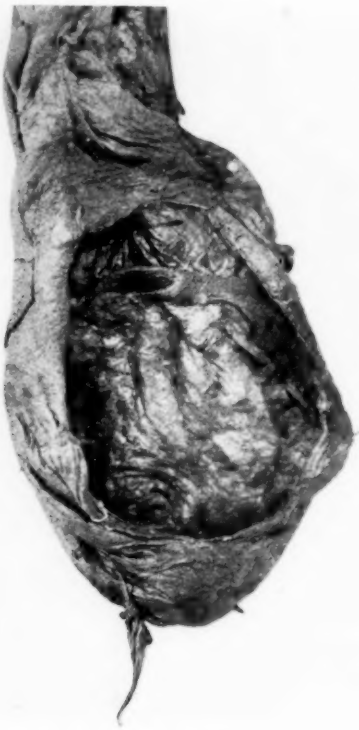

Fig. 3.

The length of the cecum from the beginning of the lower lip of the ileocecal valve up to the dome was 3½ in.; the width was 2½ in. The outer surface of the cecum was smooth and shining.

In several places strips of peritoneum from the visceral layer of the peritoneum twisted in a form of appendices could be seen; they were not, however, seen at the time of dissection and are seen now after the specimen has been for months in a preservative solution. As can be seen in Figure 1, there is a small appendix-like projection on the anterior surface of the cecum, just lateral to the ileocecal junction; another similar projection which looks like an appendix can be seen just below the ileocecal junction at the borderline of the medial and posterior surfaces of the cecum (see Fig. 2), and also a third projection is seen hanging down from the cecum (see Fig. 2). This appendix-like projection which starts below the ileocecal junction corresponds approximately to the place where normally the appendix takes its origin, because it is at the junction of the

three tenia coli. However, there was no such projection when the cecum was first exposed and it appeared only after

The second case was also found on the dissecting table. It was that of a female who died from tuberculosis.

Fig. 4.

Fig. 5.

Fig. 6.

the specimen had been lying in a preservative solution for a few months; it represents only strips of visceral peritoneum. To ascertain whether there were any traces of the opening where normally the cecum opens into the appendix, the cecum was opened and the following was found: The ileocecal valve was well developed, its upper lip more developed than the lower one which is a normal arrangement. On the inner surface of the cecum which corresponds to the point of junction of the tenia coli on the external surface, there is a smooth place, but about ½ cm. below is a little depression (see Fig. 3).

By trying to introduce a bristle, we saw that the depression ended blindly 1 mm. from the beginning. Looking from the outer side of the cecum at the pushing point of the bristle, one could see that it was pushing the wall of the cecum about .75 cm. from the root of the appendix-formed projection. Therefore it is quite clear that this little dimple had no connection whatsoever with the projection mentioned here.

At the place of junction of the three tenia coli there were no traces of appendix.

This second specimen is of great interest because it gives us some facts for critical analysis of some theories concerning the explanation of congenital absence of the appendix.

As is known, among different theories explaining absence of the appendix, the theory of Schridde[12] is one of the most accepted. According to this theory, the appendicular portion of the primitive cecum fails to become arrested in its development as it normally should, but keeps pace in growing with the cecal portion proper and at maturity is indistinguishable as to caliber from a normal cecum. The reason why he gave such an explanation was that in his case the cecum belonged to a child fifteen months old; on the cecum were present *six haustra instead of four.* (As is known, the human cecum up to the age of four or five years has deep furrows which subdivide the wall of the cecum into four haustra; these haustra normally disappear at the age of four or

five years, due to intracecal pressure of the fecal material, and the cecal wall then becomes smooth.)

The fact that in his case there were six haustra instead of four and also the absence of the appendix, made him believe that these two additional haustra are the modified appendix and he explained, on the basis of his specimen, that normally the appendix is formed by the arresting of the growth of the lower two haustra; that at some period of the embryonic stage all six haustra are of the same size and width; later on the lower two haustra are arrested in their growth and form the appendix and the upper four continue to grow and form the cecum. *Therefore, he advises: Whenever there is a congenital absence of the appendix count the number of haustra.*

In order to corroborate his theory, one has only to deal with such cecum where the haustra are present, which occurs only in cases of children up to four or five years; in grown persons there are no haustra and dealing with an absence of appendix in a grown person, one can neither corroborate nor disprove this theory unless one comes across a case of absence of the appendix in a grown person *with an infantile type of cecum* which actually is present in our second specimen.

Four deep grooves cross the antero-lateral wall of the cecum; the upper groove separates the cecum from the colon ascendens and the lower three form four haustra (see Figs. 4 and 5); the inner surface of the cecum is covered by numerous rugae; the ileocecal valve is clearly seen (see Fig. 6). In this specimen, of course, one could not look for a dimple resembling the opening of a primitive appendix on account of the rugosity of the whole lumen. This specimen does not clear up and explain the causes of agenesis of appendix. However, it shows clearly that the theory of Schridde which is considered the most reliable cannot be corroborated by our analysis.

SUMMARY

1. Agenesis of the appendix is exceptionally rare; several cases described as agenesis are rather marked hypoplasia of the appendix.

2. To verify on the operating table the absence of the appendix in case it is not seen at the place of union of the three teniae, one should mobilize the cecum from the lateral side of the cecum and examine the posterior wall of the cecum.

3. Bound down to the m. psoas major the terminal part of the ileum is very suggestive of retrocecal appendix.

4. Our findings on specimen No. 2 do not corroborate the theory of Schridde.

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SIGMOID FLEXURE IN CONSTIPATION IN CHILDREN

PRELIMINARY REPORT*

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IN the usual discussion of constipation in children, diet and habit formation are stressed. Diet is emphasized in infancy because the high calcium caseinate content of the artificial formula tends to constipate; habit formation is the motif in the older child because the behavior problem is favored in our modern pediatric treatment. Should we question their infallibility, and investigate more carefully, anatomical peculiarities of great interest may occasionally may be found. In a routine *x*-ray examination, the descending colon in many constipated children fills the lower abdomen, and the diagnosis of redundant colon, or enteroptosis is usually made. The former term is purely descriptive and of little pathological importance; the latter is usually associated with an asthenic habitus that is only rarely present before puberty. These criticisms, I feel, are warranted, for loose inaccurate terminology never stimulates further investigation.

This apparently excessive large bowel may be identified pathologically and radiologically as the sigmoid flexure, and it is the sigmoid flexure I will discuss; the etiology of its enlargement and the pathological sequelae that often demand surgical intervention.

The normal adult sigmoid flexure is usually s-shaped and small. It has been recognized since the seventeenth century that an apparently elongated and multilooped sigmoid was normal[1,2,3] in infancy,[4–7] but it remained for the memorable discussion at the French Academy of Medicine, in 1859, to crystallize the subject.

At that time it was suggested that in congenital rectal atresia, the artificial anus be made on the right side instead of the left. Huguier found that the sigmoid flexure was long and tortuous and was directed transversely in the pelvis from left to right, reaching ordinarily to the right iliac fossa. His work was subsequently altered by Bourcart, who described three types of sigmoid looping; the ascending, transverse and descending (Fig. 1).

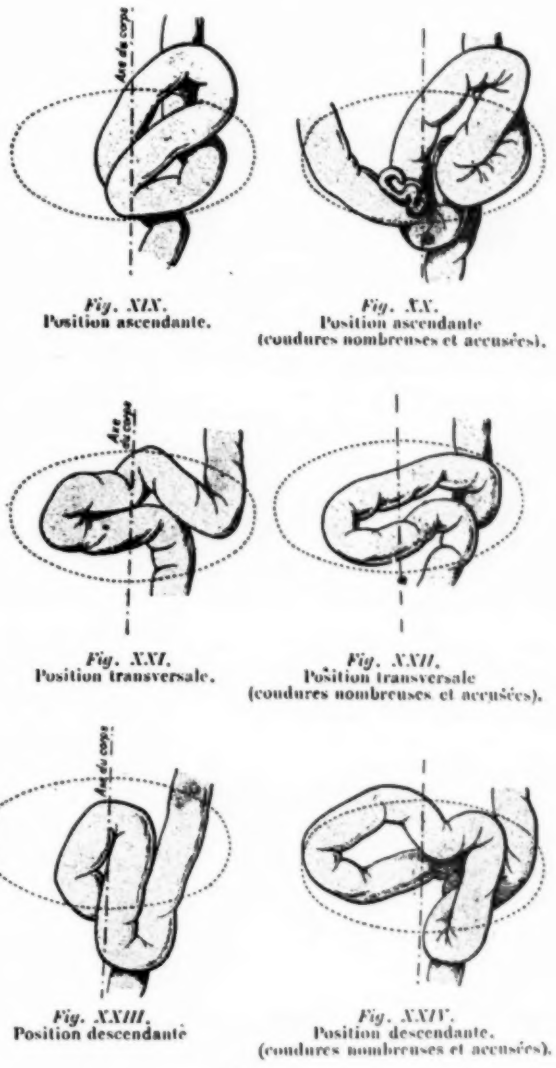

Fig. XIX. Position ascendante.

Fig. XX. Position ascendante (coudures nombreuses et accusées).

Fig. XXI. Position transversale.

Fig. XXII. Position transversale (coudures nombreuses et accusées).

Fig. XXIII. Position descendante

Fig. XXIV. Position descendante. (coudures nombreuses et accusées).

FIG. 1.

McMurrich,[8] in his manual on embryology, quoting Treves, explains the in-

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fantile peculiarities of the sigmoid and their origin in the following manner.

The lower portion of the large intestine is thrown into a loop which extends transversely across the lower part of the abdominal cavity, and represents the sigmoid flexure of the colon. At the time of birth this portion of the large intestine is relatively much longer than in the adult amounting to nearly half the length of the colon, but after the fourth postnatal month, a re-adjustment of the parts of the colon occurs, the sigmoid flexure becoming shorter and the rest of the colon proportionately longer, whereby the cecum is pushed downward until it lies in the right iliac fossa, the ascending colon being thus established.

This physiologically elongated flexure with its immaturely developed musculature lies cramped and coiled in the small pelvis of the infant. The pelvis is smaller in the male than in the female and explains the greater frequency[9] of constipation and pathological flexures in the male child. When we recognize the presence of both factors, the marked infantile looping of the sigmoid and the smallness of the pelvis, it is easily understandable why accidents occur. The elongated flexure in late prenatal or early postnatal growth when distended with meconium may kink or compress an intestinal portion with resulting acute obstruction.

We see megacolons for this reason in the fetus and often [0] in the newborn. The breast fed child, when its food is sufficient in quantity, usually has normal intestinal behavior. Nature has provided, in breast milk, a food which fulfills most accurately the metabolic requirements of infancy; it is liquid in composition and being most easily digested, absorbed and utilized, promotes normal intestinal function in the physiologically looped lower bowel.[11] This fact implies the compatibility of the breast milk feces and the adequacy of peristaltic function in propelling the intestinal material without disturbance. During development, the sigmoid flexure assumes the configuration of the adult s-shaped sigmoid.

The persistence of the infantile macrosigmoid beyond this period is no longer physiological, and retards the evacuation of artificial foods. With the institution of artificial and mixed feeding, foods more difficult to digest are retained in the intestinal tract a longer period, to insure the greatest possible utilization. With the abundant refuse and casein of the new diet, a greater bulk of fecal material is passed through the elongated flexure.[8] Habitual constipation of this weaning period inaugurates or increases the vicious circle that assures the persistence of the macrosigmoid.[14,19]

When the constipation is permitted to continue, the vicious circle formed increases the tortuous infantile flexure and, therefore, the associated constipation, and the smooth musculature of the sigmoid flexure is forced to progressively increasing exertion. According to Bloch, this musculature is not maturely developed and its reserve is, hence, not unlimited.[15,16] To recapitulate, the fecal stasis, at first inconstant and brief, becomes more or less chronic.[17] Gaseous distention follows. The sigmoid musculature eventually becomes insufficient and is unable to propel the increasingly constipated fecal material through its elongated tortuous channel.[18] Cathartics and enemas increase this insufficiency. The constant pressure of contained gas aids in forcing feces onward, yet exerts a distending influence towards its weakened walls, and habitual constipation results. Certain accessory factors may exert their influence, as the muscular atony in rickets, myxedema and severe diarrhea.

Before discussing the more serious sequelae of the elongated, or macrosigmoid, the question arises whether it represents a physiological need. During infancy, the most economic period in life, food is most accurately adapted to metabolic requirements and must be completely utilized, to prevent, in so immature an organism, general or intestinal disturbances, which may be fatal. Bloch has found glands[19] of Lieberkühn, with Paneth cells, in the

elongated colon of infancy, and Max Rubner[20] attributes the better utilization of cow's milk by the infant as compared to the adult to the presence of additional secretory glands in the elongated colon. Babak,[21] following the work of William Roux on functional adaptation, investigated the influence of various types of food upon intestinal length in the omnivorous tadpole. The more artificial the food and the more difficult its digestibility, the greater was the elongation of the colon. When we bring this work in functional physiological morphological relationship to food, we may suggest that foods abounding in cellulose and hence with difficulty digested aroused and caused a relative enlargement of the intestinal surface. With the feeding of abundant cellulose enclosed foodstuffs during the weaning period, the persistence of the macrosigmoid may be visualized as a necessary accommodation to insure adequate utilization.

The conception described is purely mechanical. Whatever rôle the vegetative or endocrine systems assume, has not yet been determined, and must be part of our future problem.

It may be advisable to state here that in my cases of macrosigmoid, glandular treatment was ineffective, and only a purely mechanical therapy brought about complete restoration of normal function.

Elizabeth F., aged six, was habitually constipated since birth. Spontaneous bowel movements never occurred. Drastic cathartics and enemas were required to effect daily defecation. The child, under constant medical care was diagnosed a behavior problem, and, for a period of years, was so treated without result.

When examined, she was 46¾ in. tall and weighed 41 lb. Physical examination was otherwise negative. Proctoscopic examination likewise revealed no pathology. A 2000 calorie diet, high refuse, with 12 per cent protein, 23 per cent fats and 65 per cent carbohydrate and one tablespoon of olive oil by mouth, was given, without results. Vitamine B was later added in the form of malt extract, and was likewise ineffective.

A 2000 calorie diet, low in refuse, and one tablespoon olive oil by mouth, was followed by almost immediate result. During six months, on this regimen, Elizabeth had two spontaneous bowel movements daily. Her weight has increased to normal from 41 lb. to 50½ lb. Nausea and anorexia have never returned.

Fig. 2.

I am presenting only 1 case, because of limitation of time. The radiologist's diagnosis was:

Stases caused by marked redundant descending colon and the trap-like effect, both hepatic and splenic flexures (Fig. 2).

A more accurate analysis suggests many important inferences. Clinically habitual constipation, nausea, anorexia, malnutrition have been present since birth. All are attributable to the intestinal pathology. Only drastic cathartics and enemas made defecation possible. The enormous elongation of the sigmoid flexure, muscularly insufficient, represents a functional, relative stenosis. Nausea and anorexia are not due as Kerley[22] suggested in his article on Enteroptosis in children, to retention of gastric contents, but to reverse peristalsis aroused by the abnormal behavior of the intestines. The apparent stasis and trap-like effect at both flexures and the forty-eight hour retention of barium in the transverse colon were also functional, and have since disappeared. With intestinal rest, all symptoms disappeared and normal intestinal behavior, after these years of muscular insufficiency, was resumed. The

musculature of the sigmoid flexure became sufficient.

Elizabeth, in her treatment, was placed

Fig. 3.

upon a high refuse diet, then one rich in vitamine B. Both were inadequate, and gave no relief. When refuse, cellulose, was subsequently removed from her diet, and oil was administered by mouth, response occurred almost immediately.

Glandular therapy given in the beginning was ineffective.

With intestinal rest, the insufficiency of the sigmoid flexure musculature became sufficient. Subsequent radiological studies have been demonstrated, showing the partial return of the markedly elongated, tortuous, insufficient sigmoid to its normal size and contour (Fig. 3).

We may consequently infer that, just as removal of refuse, reduction of gas formation and stagnation have been followed by a reduction in size of the macrosigmoid and have reestablished normal physiology, so the reverse may likely be true: that the elongation of the sigmoid, and its muscular insufficiency followed habitual constipation and the intake and retention of excessive indigestible material.

In the case presented, there is a definite clinical pathology due to abnormal behavior of the intestinal tract. We can visualize how a more pronounced muscular insufficiency can lead to a muscular decomposition, with resulting megacolon or volvulus.

Stage of Decomposition: The child with a macrosigmoid, habitually constipated, usually avoids the dangerous intestinal complications which may threaten life. When the musculature of the elongated sigmoid becomes insufficient and the peristalsis is no longer able to cause evacuations, muscular hypertrophy occurs. When decomposition becomes complete, the sigmoid, unable to empty itself, commences to dilate. Gas formation and muscular hypertrophy are temporarily able to propel feces into the rectum. With decomposition, however, the flexure becomes filled and either kinks at the rectal sigmoid junction, or forms a valve. These constitute a stenosis and the true picture of megacolon results. During any pre-megacolon stage, treatment and cure are made possible by one procedure: rest. Rest in megacolon is attained through the insertion of rectal tube facilitating a constant drainage of feces and gas; the ingestion of a diet low in refuse, and oil by mouth; or when necessary a colostomy may be done (Kerley).

Kinking occurs at the place of transition from flexure to rectum for several reasons: the presence[23] of a natural narrowing and the lack of fixation of the mesentery at this place so that the upper portion is mobile while the lower is not.

Roser has made a diagram and described[24] a type of stenosis at the rectal sigmoid junction with valve formation resulting from loop formation and fecal stasis. On rectal examination, the small or index finger when admitted, apparently enters a large sac-like cavity: despite the patency to the finger, the gruel-like contents are not satisfactorily evacuated. The colon is markedly distended and the abdomen extremely large. With the introduction of a rectal tube, the intestinal contents are evacuated, and the valvular

mechanism disappears but the stenosis recurs, when the intestinal portion above the functional structure is permitted to overfill.

The elongated sigmoid flexure and train of events, just described, lead to habitual constipation, gas formation, distention and finally decompensation of the intestinal musculature. At the rectosigmoid junction, the flexure distends against the immobile rectum, compressing it, sometimes causing a pre-megasigmoid. Such a stenosis is relieved only after long drainage, permitting the tone of the intestinal musculature to return to normal and subsequent dietary and medical care prevents the recurrence of obstinate constipation.

Although volvulus of the sigmoid does not occur during childhood, its precursor, the macrosigmoid, is definitely a part of our subject. The manner in which the macrosigmoid predisposes to volvulus is evident; time will not permit its discussion (Fig. 4).

SUMMARY

1. The sigmoid flexure of the infant is usually elongated and looped. Its mesosigmoid is attached relatively high on the vertebral column and is freely movable.

2. During infancy it represents a physiological condition in which breast milk and peristaltic adequacy result in normal bowel movements and the eventual assumption of normal adult sigmoid configuration.

3. With errors in artificial feeding, and the feeding of excessive food material which is digested with difficulty, the infantile elongated and looped sigmoid (marcosigmoid) persists, instead of assuming the normal adult contour and size.

4. The persistence of the elongated and looped sigmoid flexure beyond infancy represents a pathological situation which is an etiological factor in the causation of chronic constipation, megacolon and volvulus. In the clinical histories of these conditions, the constipation dates always from birth or from the time of weaning.

5. The abnormal position of the infantile, macrosigmoid in the adult sometimes leads to carcinoma of the sigmoid and may interfere with the correct diagnosis of exudates or tumors in the right iliac region, should it extend thereto.

6. This conception stimulates the early recognition of the pre-Hirschsprung and pre-volvulous stages. Through proper therapy, such disastrous entities may sometimes be prophylactically treated.

7. The treatment is essentially one of rest. The feeding of foods easily digested, of as little bulk as possible is called for, for cellulose and refuse cause fecal stagnation, gas formation and intestinal distension. Removal of refuse makes intestinal rest possible. The secondary injuries to the abdominal wall of inflammatory nature tend to subside with a low refuse diet and

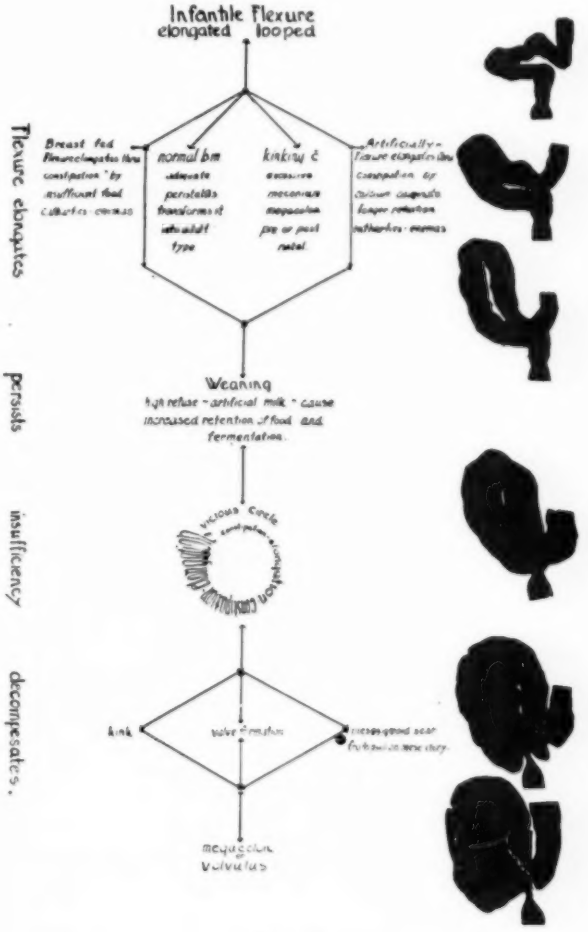

Fig. 4.

the addition of oil by mouth. Alvarez has emphasized the rapidity with which the distended colonic musculature fatigues and assumes a refactory condition.

Its tone returns. The decompensated intestinal musculature responds to rest as does the musculature of the heart, and without intestinal rest, healing cannot occur.

8. By these therapeutic means, the persistent infantile elongated flexure is readily responsive and in time, according to our investigations, will assume the normal shape and size in the child.

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*Continued from p. 320.

PRESENT CONCEPTION AND TREATMENT OF SHOCK*

H. L. WENGER, M.D.

PATERSON, N. J., AND WOODSIDE, L. I.

IN spite of the vast amount of experimental work and clinical data available, the subject of shock, both medical and surgical, is still little understood. There have been assumed many and varied explanations of the condition, some of which are still accepted as at least in part correct. Others have been discarded entirely.

The mechanism of surgical shock has been studied recently by capable men, among them being Cannon, Henderson, and Crile. A number of facts has been definitely established.[1] Crile believed that shock was caused by exhaustion of the vasomotor center by excessive stimulation of the nerve fibers in injured parts of the body. However, later experiments proved that in shocked animals the vasomotor center remains active and that local vasomotor relaxation follows section of the nerve trunk. Later[1] Henderson demonstrated that in the early stages of shock, the blood pressure remained unchanged, although there was a diminished flow of blood from the heart, which demonstrated that for a time at least the vasoconstricting mechanism is intact.

These experiments were later confirmed by artificially producing shock. It was observed that in the cat shock could be induced by traumatizing the flexor group of muscles of the thigh by crushing with pincers (not by hammering).

Prior to producing injury to the muscle, the cord in the lumbar region was severed. Yet when the muscle had been crushed with pincers, shock resulted. The experiment was carried still further by cutting the nerves to the limb at the point of emergence from the pelvis. Furthermore, the shock was not produced when the nerves were allowed to remain intact with the blood vessels tied, i.e., the blood supply to the muscles which were injured was destroyed. This experiment clearly proved that some substance, which was given off by the injured muscle itself (eighteen to twenty minutes after injury) was the cause of the drop in blood pressure. This shock occurred only after the blood was permitted to flow into and out of the damaged region. This clever experiment was performed by Cannon[2] of the British Shock Committee.

Dale and Laidlow[3] studied experimental shock by injecting histamine, which in the cat family causes typical shock-like failure of the circulation. The picture resulting from the injection was similar in every respect to the shock which resulted from the local injury to a muscle or group of muscles, when injured by crushing. The studies of these men were rather complete. Blood pressure readings, blood chemistry, hemoglobin, cell counts, and plasma volumes were recorded in both the arterial and the venous blood; and finally there was examination of the organs. The vena cava in the thorax was found to be flaccid and half empty. The condition of the portal vein was the same. The arteries, both large and small, also contained little blood and were found to be constricted rather than dilated. This latter finding appeared to be paradoxical in the face of a low blood pressure. The amount of blood in the liver and in the spleen was markedly decreased.

Since the blood was not to be found in the larger vessels or in the organs in which one would expect to find it, it was necessary to seek elsewhere for the missing volume. The small volume of blood which was found remaining in the vessels was concentrated,

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i.e., there was an increase in the proportion of solid elements. The loss in volume was chiefly, then, due to a loss in the plasma. By exclusion, this blood was located in the capillaries. These findings seemed to point to the fact that capillary tone must be lost throughout the body.

And thus we have in shock a picture of the blood rapidly leaving the veins, causing the venous pressure to fall. The heart consequently does not fill in diastole; its output decreases and there is a fall in blood pressure. The arterial constriction is apparently an attempt to compensate for the fall in blood pressure. In reality it causes a greater stagnation in the capillaries. This cycle can only be explained by a loss in capillary tone.

The British Shock Committee[2,3] performed further complete studies which confirmed these findings. To determine blood volume, they injected vital red stain in the normal animal and in the animal in shock. By the use of the Duboscq colorimeter, plasma volumes were then estimated. They thus definitely showed the loss in blood volume in shock where no actual hemorrhage had taken place.

Through these experiments certain conclusions are to be drawn. The marked hypotension in surgical shock is not due mainly to a loss of arterial tone or to failure on the part of the heart. It is apparently due to a lessened flow of blood to the right auricle, caused mainly by an accumulation of blood in the capillaries and a loss of plasma from the greater vascular tree. This accumulation might be brought about by a direct injury to the part (as in surgical operation) or it might be caused by vascular poisons absorbed from damaged tissues. (A case of shock due to snake bite poisoning is reported by Atchley.[5])

Clinically these cases show a low or falling arterial pressure, a rapid thready pulse, a subnormal temperature, cold skin, moist with perspiration, a pallid or grayish or slightly cyanotic appearance.

This condition is met with frequently in the active hospital; and as a rule, "routine treatment" is ordered. Usually this consists in application of heat, sedatives for pain and restlessness, and fluids; and in severe cases, elevation of the foot of the bed. But it is chiefly with the restoration of a deficient circulation that we should concern ourselves. Stimulants have been discarded as ineffectual. Cardiac stimulation in the absence of cardiac disease is not indicated. Adrenalin is contraindicated because it causes further constriction of the arterial vessels and not an increased nutritive flow through the capillaries. This restoration of volume can only be obtained by increasing the volume flow.

Fluids may be given by mouth or by rectum. But these routes are often either impossible or inadequate. Fluids given subcutaneously are absorbed too slowly by the damaged capillaries, especially if the shock is at all severe. Intravenous injection is really the only method by which the volume of circulating fluid may be increased quickly and surely.

Blood transfusion is undoubtedly the best way of restoring volume; but this has the disadvantages of not being available or of the supply's not being adequate, not to speak of the time element and technical procedure necessary. Many substitutes for whole blood have been used. Among those in use are acacia, hypertonic glucose, normal saline, and combinations of two or more of these. Theoretically, acacia has the proper viscosity and the osmotic pressure of the blood colloids and it is chemically inert and harmless. Thus it retards the passage of the water from the vessels. However, there are objections to the use of acacia, chief among these being reports of anaphylaxis.

Hypertonic glucose increases the blood volume and extracts fluids from the tissues into the vessels, and at the same time supplies carbohydrates. But since Cannon showed that the blood sugar is above normal in shock and that there is no decrease in the alkali reserve, I see no indication for the employment of this solution. There are no acetone bodies in the urine.

The loss of plasma volume in shock differs, for example, from the loss found in the diarrheas of infancy in that it is not accompanied by acidosis.[6] Podgett and Orr, in treating experimental shock with glucose solutions, found almost identical results whether given with or without insulin. It seems most likely that the beneficial effects of the glucose solution are due mainly to the water introduced with the glucose.

Experience till recently with the use of normal saline solution has not been entirely satisfactory. The explanation of its failure was thought to be due to the fact that since it is a crystalloid solution, it is so readily permeable that it does not maintain the blood pressure increase that follows immediately on the injection. Recently, however, the work of McFee and Balbridge[6] with saline solutions and Warthen's with dextrose have stimulated the use of intravenous infusions in larger quantities. It seems from the work they report that the value of intravenous infusion was not fully appreciated because the quantity of fluid used was insufficient. In the surgical department of the Johns Hopkins Hospital from 300 to 1000 c.c. of 5 per cent dextrose in normal saline is given by needle, three way stopcock, syringe method, when only a small amount of intravenous fluid is needed to overcome shock. When, however, the condition of the patient necessitating the initial administration is likely to persist, or when the patient has veins unsuitable for repeated punctures, a cannula is inserted into the incised vein and continuous flow is maintained[7] (Hendon method).

In the few cases which we have treated with large quantities of intravenous infusion, the results have been gratifying. One case of intestinal obstruction received 3300 c.c. of saline in twenty-four hours, following resection of 14 in. of gut. In this case lacrimation appeared and the infusion was stopped. Since the blood chlorides are rapidly lost in intestinal obstruction with the vomiting, it was thought that in this case the infusion was the decisive factor in the patient's recovery. Another patient having appendicitis with peritonitis whose

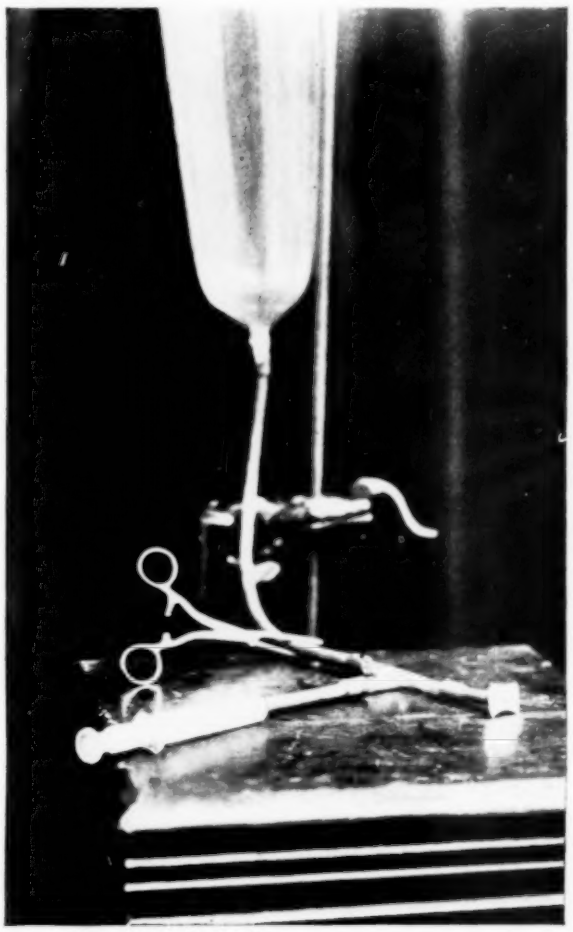

Fig. 1.

systolic pressure was 100 after incision and drainage under nitrous oxide anesthesia, was given a total of 4000 c.c. of normal saline intravenously in two doses within forty-eight hours postoperative. In this case the opinion prevailed that the infusion was the therapy that turned the tide in the patient's condition.

The amount of fluid used varies in many clinics. But water intoxication should not take place if the blood pressure is carefully watched and if the injection is discontinued when the patient begins to perspire or has lacrimation. I have given as high as 1700 c.c. in one hour to a patient in shock following gastroenterostomy for malignant obstruction. There was no ill effect. In this

case the systolic pressure was 105 on leaving the table and following the infusion it rose to 150. This patient had a moist tongue and lips for twenty-four hours following the procedure and of course no fluid was required by mouth.

Some of the patients had chills immediately following the infusion of the saline. Matas[8] feels that a chill following this therapy is an indication of resistance and vitality, because it was absent in his more debilitated subjects. He found that a larger percentage of his cases having reactions recover. This then may be of some prognostic value.

I have found it difficult to give large quantities of fluid intravenously with the usual gravity method. Among other objections, this gravity method is too slow. Because of these inconveniences, the Scannell apparatus for transfusion was used. However, it is cumbersome and somewhat complicated. The apparatus described below is an outgrowth of these difficulties.

A glass T-tube is inserted between the gravity tube and the needle, which needle should preferably be of the type with a shield to rest on the patient's arm. To the perpendicular of the T-tube, by means of rubber tubing, a 50 c.c. Luer syringe is attached. The other equipment required is the ordinary infusion bottle for transfusion and an artery clamp.

The artery clamp is placed on the tubing just above the T-tube. When the clamp is removed, the fluid flows into the vein and into the syringe displacing the plunger. When the syringe is full, the clamp is reapplied; gentle pressure is exerted on the syringe, thus forcing the fluid into the vein. The clamp is removed and the procedure repeated until sufficient fluid has been given. In my cases 500 c.c. are given in a period of from thirty to forty minutes. In no case have there been any ill effects from giving the fluid at this rate.

The advantages of the apparatus lie in its simplicity; in the fact that the treatment can be given at the bedside; that the patient is but slightly disturbed; that a large volume of fluid may be given in a minimum of time; and that the flow into the vein is continuous. Thus there is no clotting in the needle.

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OPERATIVE TREATMENT FOR ADRENAL CORTICAL OBESITY*

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IT is well recognized that one type of obesity frequently encountered is due to an endocrine imbalance. This imbalance may be precipitated by an altered activity of one, or any combination, of several glands which include the gonads, the thyroid, the pituitary and the adrenals. The obesity occasioned by a disturbance in the adrenals is perhaps less often recognized and understood than that of any other group. The eunuchoid, the hypothyroid, and the hypopituitary types are well known and readily diagnosed. It is our impression that the type due to adrenal disturbance also presents a very definite syndrome. The obesity of adrenal origin is always associated with a disturbance in the cortex. This disturbance is based on either a diffuse cortical hyperplasia or a cortical neoplasm. These pathological changes produce three different syndromes depending upon the age of the individual at the time of their development. If the lesion occurs during intrauterine life, there is a disturbance in sexual development causing hermaphroditism, in a large number of cases. When the pathological changes begin during early infancy, precocious sexual development results. This type is by far more common in the female, and is very often associated with obesity, excepting when the adrenal cortex is the seat of malignant neoplasm. The third type develops during adult life and is accompanied by obesity, changes in the secondary sexual characteristics toward the male line, such as hirsutism, thickening of the skin and changes in the voice. Amenorrhea of variable duration is a concomitant feature. The obesity may reach extraordinary degrees. The fat is generally distributed with an accentuated deposition in the hips, buttocks and abdomen, breasts, thighs and arms. The forearms and legs are frequently singularly free from fat accumulation. The hands and feet are rather small. Related to this third group is the obesity in old women with the growth of hair in the face. Examination of the adrenals in the latter cases invariably reveals the presence of one or several cortical adenomas.

It has been known for some time that the adrenal cortex influences fat metabolism. This relationship has been experimentally demonstrated by the fixation of blood fats in the tissues after injection of interrenin, the specific principle of the adrenal cortex isolated by one of us[1,2]. These observations have been confirmed recently by Kohno,[3] Schmitz and Milbradt,[4] Reiss[5] and others. In the light of these facts some older experiments gain new interest. Adler,[6] McKinlay and Fischer,[7] Castaldi,[8] Fieschi[9] and others obtained a considerable increase in body weight if they fed their animals dried adrenal cortex. McKinlay and Fischer also observed a stimulation in the development of the testicles while Adler who fed dried cortical adenoma to tadpoles obtained premature male sexual development together with rapid growth. Very important are also the observations of Iscovesco[10] and Fieschi who both saw a rapid growth of hair in rabbits after shaving if they were fed cortical substance.

The relationship of cortical hormone to fat metabolism and the results of the feeding experiments quoted here seem to indicate that a hyperactivity of adrenal cortex may be able to produce pathological fat deposition and may also account for pathological growth of hair. The logical conclusion therefore is that obesity and hirsutism accompanying adrenal cortical hyperplasia or tumor are an expression of cortical hyperfunction. On this basis it is

* From the Surgical and Pathological Services of the Crown Heights Hospital.
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rational to propose similar surgical therapy to that advocated for other hyperfunctioning glands, as for example the thyroid.

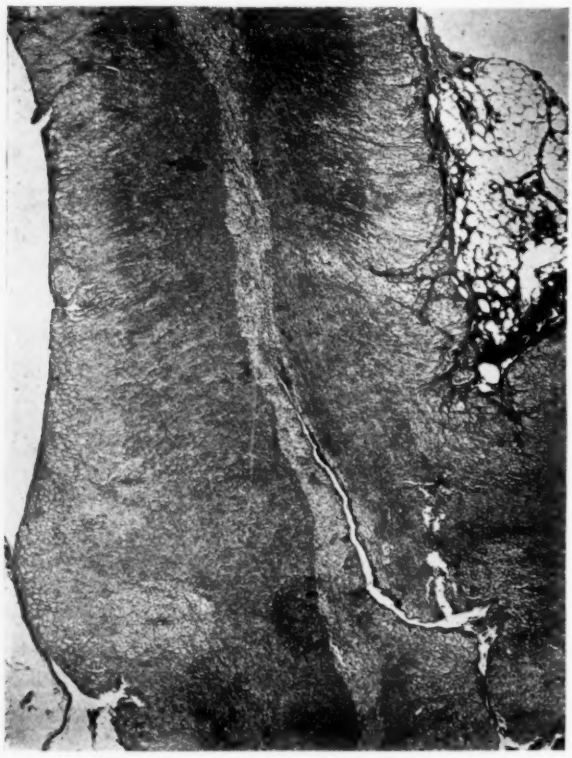

Fig. 1. Low power view of whole cross-section of adrenal gland. Note two distinct strata of cortex and narrow layer of medullary tissue in center.

This line of thought was put to the test in the following case.

K. B. female, twenty-three years old, complaining of extreme obesity was admitted to the Crown Heights Hospital on Sept. 27, 1929. She is one of seven children, all others of whom are perfectly well. There is no history of metabolic disturbance in the family. She began menstruating at the age of thirteen. She was very irregular, the intervals varying from two weeks to three months. The flow lasted seven days, was scanty, and without pain. Her appetite was voracious, she was not constipated, had no nausea, belching or polydipsia. She had a marked frequency of urination and nocturia, often voiding as many as fifteen times a night. At twelve she had influenza, at which time she weighed 100 lb. During convalescence after "tonic" treatment she began to gain weight, so that within a year she gained 75 lb. She continued to gain progressively until on admission (eleven years later) she weighed 335 lb. One hundred and twenty-five pounds of that weight were gained in the past year. Her voice became deep rough and masculine in character. Hair began to appear on her chest, face, abdomen, forearms and legs.

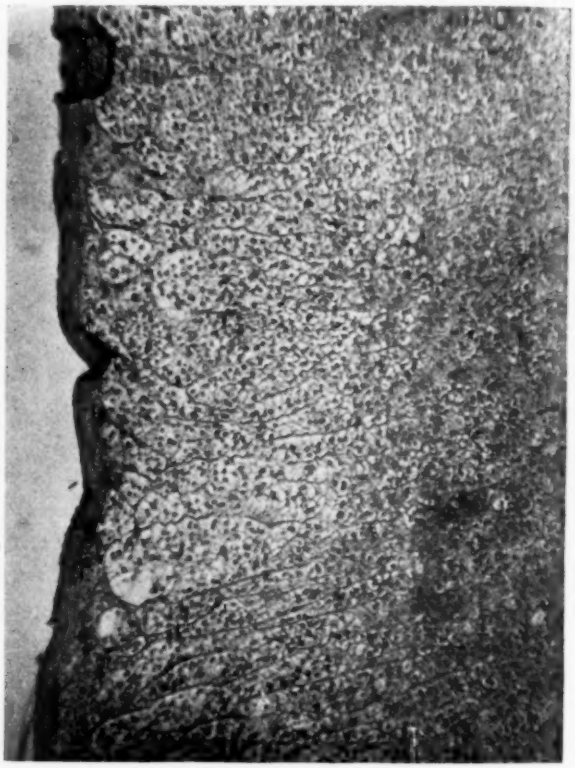

Fig. 2. Cortex of adrenal. Outer stratum with extensive lipoidosis. Intermediary stratum with darker cells containing but little lipoid. Low power.

On examination she presented the following findings: A young woman extremely obese, with fat distribution particularly in the region of her abdomen, hips, arms and thighs. There was a marked growth of hair on her face, extremities, breasts and a masculine distribution of pubic hair extending up to the umbilicus. Her voice was deep and her skin thick.

Laboratory Findings: Urine, specific gravity 1018, no albumin, no sugar, microscopic negative. Blood count, hemoglobin 85 per cent, red blood corpuscles 5,160,000, white blood corpuscle 8,500, polynuclears 78 per cent. Blood pressure 105/62, lymphocytes 21 per cent, monocytes 1 per cent. *X*-ray, skull showed a normal sella turcica. Wassermann test negative. Kahn-test negative. Basal metal rate, plus 8 per cent. Blood chemistry, sugar 120, creatinine 1.1, urea 10.0.

A perirenal insufflation of both kidneys was performed with the purpose of visualizing the adrenals by means of the *x*-ray, but the extreme obesity prevented obtaining a conclusive result.

Fig. 3. External portion of cortex with extensive lipoids. High power.

Diagnosis: On the basis of these findings the diagnosis of hyperfunction of the adrenal cortex was made. The differential pathological diagnosis between cortical adenoma and diffuse bilateral hyperplasia, however, was merely speculative and had to wait surgical inspection.

Operation and Findings: The incision extended from the tip of the last right rib to the anterior superior spine, down to the perirenal fat. This was stripped from the kidney which was then drawn into the lower angle of the wound, covered by a lap sponge and held there by a retractor. The hand was then introduced high into the vault of the exposed area and the fingers found the adrenal gland in the fat. It was easily recognized by its firmer consistency and slightly granular surface. It might be noted here that if any difficulty is experienced in exposing it to view, it is easily obviated by resection of the last rib. A ring clamp placed on the organ helps expose it to view. The right adrenal so exposed was very much hypertrophied, probably three times the size of a normal gland. No adenomas were visible, the surface was regular and smooth. The wound

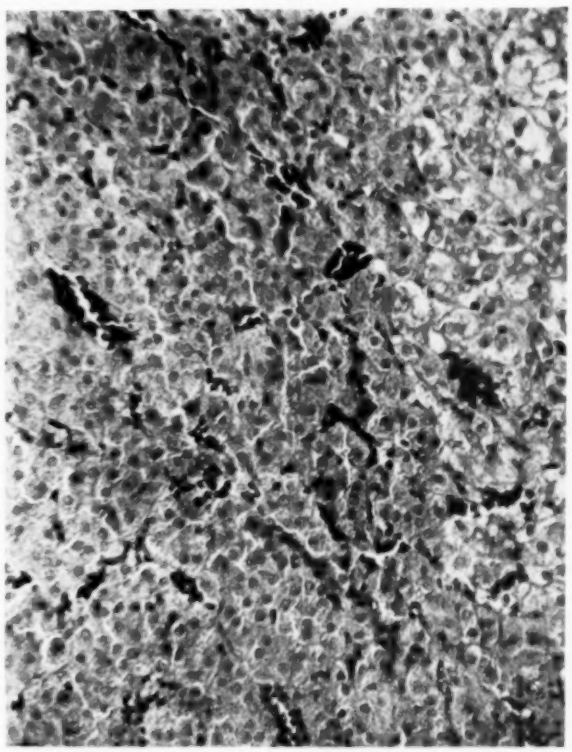

Fig. 4. Central stratum of cortex and pheochrome tissue. Cortical cells darker and granular. Many capillaries filled with red blood cells. High power.

was closed in layers and a similar incision made on the left side so that the left adrenal might be exposed. This was even slightly larger than the right, had a smooth surface, showed no adenomatous growth and was therefore resected after the blood vessels entering it were ligated. A cigarette drain was placed in the vault, the kidney was reposited and the wound was also sutured in layers. The drain was removed in forty eight hours and the wound treated like that of a nephrectomy or pyelotomy operation. Primary union was obtained on the eighth day, the sutures were then removed and the patient proceeded to convalesce uninterruptedly.

Pathological Findings: The measurements of the gland were as follows:

Length	62 mm.
Width	39 mm.
Thickness	11 mm.
Weight	16 grams

The gland is embedded in soft yellow fat tissue. It takes careful preparation to separate

this from the surface of the gland. The gland itself is light yellow in color and fairly soft to touch. Its substance is somewhat friable as a result of which the gland was slightly injured on removal. Sections made perpendicularly to the longest diameter of the gland show a rather broad cortex which divides clearly into two strata. The outer layer which is about 3 mm. in width is of bright yellow color. The other stratum is of a darker brownish color. Compared to the bulk of the cortical tissue there is but scanty medullary tissue present (Fig. 1). Only at the lower pole and corresponding to the hilum of the gland are more substantial amounts of medullary tissue found.

Microscopical examination shows that the glomerular layer of the cortex has practically disappeared inasmuch as the fasciculata reaches up to the capsule (Fig. 2). The cells of this layer are very large and look like plant cells (Fig. 3). The vacuolar character of these cells ceases almost abruptly, for the polyhedral cells of the deeper stratum are well stained and their cytoplasm is finely granular (Fig. 4). These cells stain quite well with eosin but they are slightly basophilic. The solid mass of these cortical cells shows scattered islands of vacuolar cells similar to those of the outer stratum. The central portion of the cortical tissue surrounding the larger vessels or bordering on the medullary tissue shows a great deal of brown, finely granular pigment.

The cells of the medullary tissue are large, polyhedral, with abundant chromaffine granulation. They are imbedded in a fine reticulum and separated by a multitude of capillaries most of which seem to be collapsed. The larger veins of the gland particularly those close to the hilum show well developed musculature.

Postoperative Course: This was uneventful, the patient leaving the hospital with both wounds healed fourteen days after operation. During her stay the highest temperature was 100°F. on the second day postoperative. The blood pressure which two days after operation was 105/62 rose so that on the sixth day it was 146/68. On discharge it was 110/60.

The first month she lost 25 lb. and thereafter 15 lb. a month so that on October 8, 1930, she weighed 190 lb., having lost a total of 145 lb. This loss is even more significant because before she came under our observation she had received 12 grains of thyroid extract daily over a period of nine months with a total loss of weight of only 17 lb., following which period she gained 125 lb. in the course of a year. At the time she took thyroid treatment her basal metabolic rate had risen to plus 38 per cent. For the first two months after her operation she menstruated every two weeks and since then her menstrual periods have been regular every month for a period of five days.

Six weeks after operation the patient reported the observation that the hair on her head had lost its normal curl and became quite straight.

Her nocturia has been reduced to twice a night. Her appetite is normal. It is to be stressed that since operation, she has received no medication, nor has she been subjected to any dietary restrictions.

Discussion: The striking results obtained in this case by unilateral adrenalectomy vividly demonstrate the value of reducing the mass of hyperactive cortex in the treatment of this type of obesity. The rationale is similar to that of subtotal thyroidectomy for hyperthyroidism.

The success of this operation induced us to try the same in another case which we believed might have a similar pathological basis, in spite of certain clinical differences, such as fat forearms and legs; broad, heavier bones in the hands and feet, heavy bones in the face with marked molar prominences, normal menstrual history. Surgical exploration however, revealed adrenals of not more than ordinary size. Histological examination of one of the glands, removed at operation, failed to demonstrate changes of the cortex. The postoperative observation of this patient did not show any noteworthy depletion of the fat deposits.

This observation emphasized the importance of an accurate diagnosis of adrenal cortical hyperfunction before the removal of an adrenal for the cure of obesity, nor should an adrenal gland be removed before the other gland had been inspected. This is particularly important in the cases where the adrenal lesion consists of a unilateral adenoma, in which the other gland might appear practically normal. In a case of bilateral hyperplasia like the one reported here, the choice remains with the surgeon who probably will find it easier to remove the left gland.

Conclusion: A successful operative treatment has been described for the cure of obesity due to adrenal cortical hyperfunction.

[For References see p. 317.]

A CASE OF
SPONTANEOUS HEMOPNEUMOTHORAX
(WITH SOME SIMULATION OF AN ACUTE SURGICAL ABDOMINAL CONDITION)*

A. T. MILHORAT, M.D.

NEW YORK

RECENTLY Hurxthal[1] reported a case of spontaneous hemopneumothorax in a young male who presented many of the symptoms characteristic an acute surgical abdominal condition. of This article and that of Doria[2] published about the same time are the only reports in the literature that we have been able to find of the occurrence of hemopneumothorax without preceding trauma. The former report is of especial interest and importance because the symptomatology at first suggested the need of surgical intervention in a case where such procedure would be fraught with grave danger.

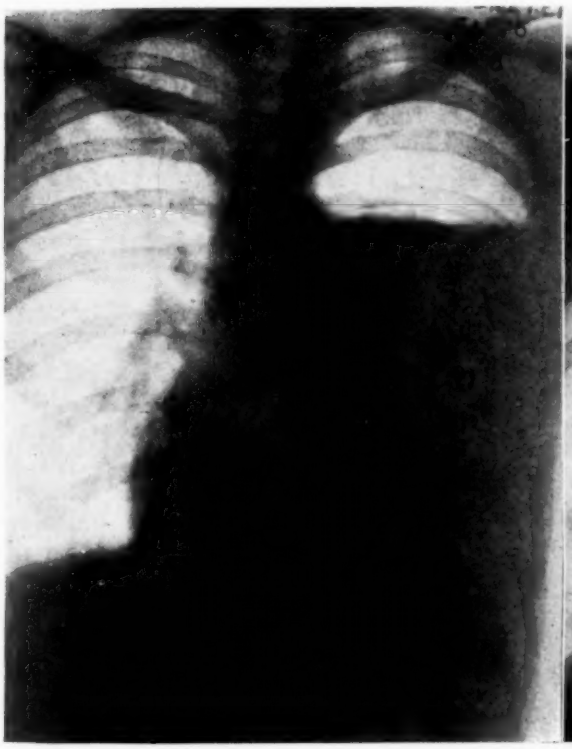

FIG. 1.

FIG. 2. Three months after onset of illness.

During the past year we have followed a case that resembles Hurxthal's in practically every detail, and the striking similarity of the two, we believe, warrants the reporting of this rare and interesting condition.

R. Z., a twenty-year old Cuban office worker, was referred to this hospital by his physician on May 3, 1929, with the provisional diagnosis of acute appendicitis. He had been well previous to twenty-four hours before

[1] Hurxthal, L. M. An unusual case of spontaneous idiopathic hemopneumothorax with certain features resembling an acute surgical abdomen. *New England J. M.*, 198: 687, 1928.

[2] Doria, R. Emopneumotrace spontaneo con versamento bloccato. *Riforma med.*, 44: 552, 1928.

*From the Department of Medicine, College of Physicians and Surgeons of Columbia University and the Presbyterian Hospital, New York City. Submitted for publication November 28, 1930.

admission when he felt a sudden, steady, sharp pain in the left shoulder while riding comfortably in the subway. The pain later

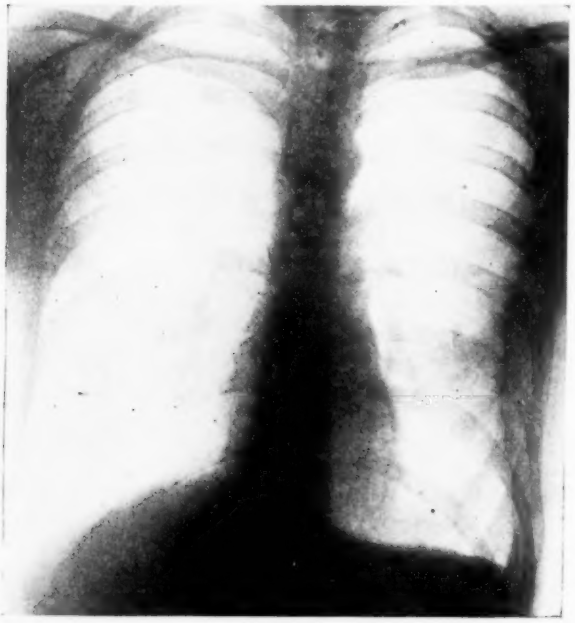

Fig. 3.

spread to the precordium and came to be worse on inspiration, making it difficult for him to breathe. He went to bed but was unable to sleep because of dyspnea, while the pain persisted and gradually extended to include the whole left chest. Twelve hours after the onset of his symptoms he developed a pain in the mid-epigastrium which spread over the entire abdomen and was most severe just below the xiphoid cartilage and in the right lower quadrant. There was no vomiting, cough or hemoptysis.

Past History: He was always healthy until two years before admission. Since then he has had frequent colds winter and summer, but worse in winter. He had chicken-pox at six years, mumps at ten years, and influenza in 1923. Eleven months before his present illness he had pleurisy without effusion on the left side, and was in bed for five weeks. He has had no chronic cough, no night sweats, and no hemoptysis. The family history was essentially irrelevant.

Physical examination showed a well-developed and well nourished lanky boy slightly dyspneic but not orthopneic. He was quite pale and without evident cyanosis. The pulse was slightly rapid but full and of good quality; the blood pressure was 104/70. The left chest barely moved with respiration; it was markedly hyperresonant throughout except below the level of the sixth rib, where there were flatness and egophony; tactile fremitus and breath sounds were absent, and the spoken and whispered voice sounds were greatly diminished. A definite succussion splash could be heard.

The right chest was resonant and clear with breath sounds that were slightly high pitched. The trachea was deviated to the right, and the heart was displaced to the nipple line on the right side.

Examination of the abdomen showed diffuse rigidity. Both recti were spastic and there was moderate tenderness (direct and rebound) over McBurney's point and below the left costal margin. On rectal examination there was tenderness on all sides, somewhat more marked on the right and posteriorly.

A blood count showed 3,100,000 red cells, 60 per cent hemoglobin (Sahli), and 19,400 leucocytes with 81 per cent polymorphonuclears.

The possibility of there being an acute surgical lesion in the abdomen was considered, but after a careful and complete physical examination had been made it was felt that the abdominal pain, rigidity and tenderness were secondary to the condition in the thorax.

Exploratory thoracentesis of the left chest (seventh interspace posteriorly) yielded pure blood, which was sterile on culture. Radiograph of the chest taken while the patient was in an upright position showed a large amount of fluid in the left chest with a very definite fluid line at the level of the fifth rib posteriorly. At the top of this fluid the lung was collapsed and replaced by air. The heart shadow was displaced to the right, and the right lung field was clear. (See Fig. I.)

Treatment was conservative consisting of complete rest with liberal amounts of sedative and several small careful thoracenteses. At the end of the patient's first week in the hospital a transfusion of 500 c.c. of blood was given, and another of 400 c.c. at the end of the third week. After fourteen days, weekly thoracenteses were done, and from 400 to 500 c.c. of bloody fluid were removed each time until after the fifth procedure when the fluid had become so viscid that only 60 to 150 c.c. could be obtained. Seven thoracenteses in all were performed.

The patient slowly but steadily improved. For about ten weeks he had a low grade fever with daily rises in temperature to 100.6–101°F., but the course thereafter was practically afeb-

rile. Frequent radiographs of the chest, and the physical signs demonstrated a gradual absorption of the air, a progressive re-expansion of the collapsed lung, and a return of the heart toward its normal site. Two and a half months after his admission, the use of blow bottles was permitted, and a week later the patient was allowed to get up. On discharge, fourteen weeks after the onset of his illness, only a small amount of fluid still remained. The left chest showed some flattening and the intercostal spaces on that side were narrowed. The red blood cell count was 5,950,000, and hemoglobin 105 per cent (Sahli); there were 14,400 leucocytes with 64 per cent polymorphonuclears.

Although the previous history of pleurisy suggests a tuberculous condition, no direct evidence of tuberculosis or of purpura could be found. Repeated sputum examinations (14) showed no acid-fast organisms, and the bleeding time, clotting time and blood platelet count were normal. No shadows suggestive of tuberculosis could be seen in the radiograph of the right lung, or of the re-expanded left lung. The thoracentesis fluid was persistently sterile on culture, and produced no tuberculous lesions when injected into a guinea-pig.

After a short rest in the country the patient returned to his home in Cuba. A radiograph of the chest taken about four months later, which he very kindly sent us, shows the lung fields to be clear, and the fluid almost completely absorbed. There was still some retraction of the left chest as evidenced by the somewhat narrow intercostal spaces. (See Fig. 3.)

Six months after his discharge (nine months after his accident) the patient reported that he was doing very well. He had gained weight steadily, had returned to work, and was free of all symptoms the least bit suggestive of his former illness.

SUMMARY

A case of spontaneous hemopneumothorax is reported in which the abdominal signs simulated those of an acute surgical lesion. No definite evidence of tuberculosis could be found. Treatment was conservative with several small thoracenteses. Improvement was gradual and complete.

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* Continued from p. 314.

NEW ABDOMINAL RETRACTOR*

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NEW YORK

THERE are many abdominal retractors on the market: They are either "self-retaining" or movable. The

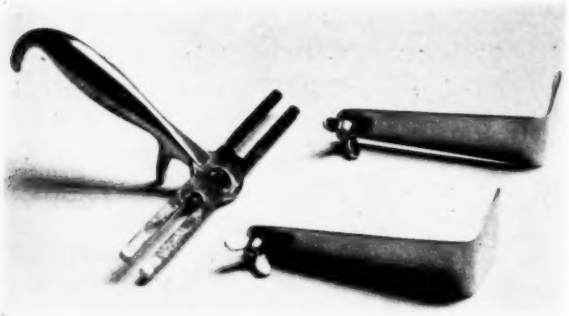

FIG. 1.

self-retaining retractors give sufficient tissue exposure but are difficult to handle, are time consuming in application and exert too much force to maintain in position. The movable retractors on the other hand are easily applied and manipulated, but the area of exposure is small and to expose a large field several retractors are required. Consequently several assistants are necessary.

To secure an instrument that is easily manipulated, that exposes a larger area, and reduces the number of assistants, I have designed the retractor described here:

It consists of a cross bar and handle made of very light, but strong steel. The bar is 8 in. long and ¾ in. wide, and has the appear-

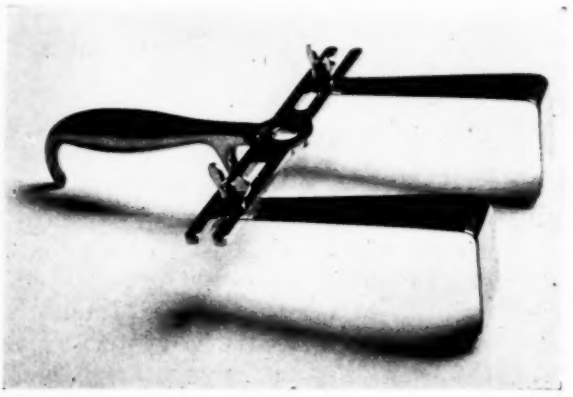

FIG. 2.

ance of two tuning forks fused together. Into each end of the bar a blade is inserted and made tight by means of a winged nut. A retractor with two blades is thus obtained. The blades can be turned in to any angle, in case the exposure of a corner be desired. They can also be moved along the bar to fit the size of the incision.

I have used this retractor and found it easy to manipulate, and to give adequate tissue exposure with fewer assistants.

* Submitted for publication December 31, 1930.

THE SLOUGH AFTER INJECTION TREATMENT OF VARICOSE VEINS*

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CHICAGO, ILL.

HISTORY repeats itself. When a new drug is synthetized, a new biological product isolated or a new procedure devised, a wave of enthusiasm follows the introduction of the method. When salvarsan made its first appearance it was hailed as a panacea for the entire line of human ailments. Mercurochrome and insulin have been used as therapeutic agents in an endless variety of diseases. Gradually the enthusiasm subsides and the field of usefulness of the drug becomes limited to those ailments where it really proves effective.

When the injection treatment of varicose veins was first advocated and tried on a large scale by Linger, Sicar and Nobl, working independently, a deluge of favorable reports followed in every country. No untoward reactions were mentioned in the literature until recently. Theoretically three different dangers are possible: (1) pulmonary embolism; (2) infectious thrombophlebitis; (3) local necrosis. Experience showed that the first complication can be practically disregarded provided that a careful technique and necessary skill are used. A septic thrombophlebitis is a very serious complication but fortunately of rare occurrence. On the other hand, local reactions seem to be more frequent than can be judged from the reports. This lack in the literature can be ascribed only to two factors: (1) incomplete presentation of the facts by the authors of papers on this subject. Being enthusiastic about their pet solution or looking at their method of injections through rose colored glasses they are likely to forget the small percentage of cases where a slough occurred. (2) Lack of publications of bad results by physicians who do not treat many patients with varicose veins and therefore do not have the opportunity to acquire great skill. It is only natural that those physicians who treat hundreds of such patients and make thousands of injections possess great skill; hence few or no misfortunes. As the majority of papers dealing with the chemical obliteration of varicose veins comes from the hand of such exceptionally experienced physicians it is obvious that the literature does not give a true picture of the situation. And yet, sloughs after injections occur even in the hands of a skillful physician and the experience in treating such complications should be reported for the benefit of all.

The axiom still stands good: "no irritation—no obliteration." In other words, a chemical which does not irritate the intima of the vein is not capable of forming a thrombus and of obliterating the lumen of the vessel. The endothelium of a vein may be and probably is more sensitive to a chemical irritant than the perivascular tissue but it is only a matter of a higher degree of sensitiveness as no irritant is known to have a selective affinity exclusively for the endothelial lining of the vein and be harmless to the subcutaneous tissues. Therefore if such a substance due to a faulty technique or leakage through the wall of the vein comes in contact with the perivascular tissues, a reaction must be expected. Some chemicals such as sodium chloride or sodium salicylate are violent irritants and may lead to necrosis more easily than some other substances, e.g., sugar or quinine and urea.

Dr. Norman J. Kilbourne[1] deserves credit for calling attention to such cases in the American medical literature. Dr. Eugene J. Garvin[2] also mentions that he had a case of sloughing after injection of 20 per cent solution of sodium chloride. Several reports of necrosis after injections appeared previously in European maga-

* Submitted for publication November 14, 1930.

zines. Walter K. Fraenkel[3] saw several cases of sloughing after injection of sodium chloride. Vogel[4] and H. Biberstein[5] report similar experiences.

Unfortunately none of the authors except Dr. Kilbourne devotes any space to the discussion of the treatment of such sloughs.

A necrosis occurred in one of my cases after injection of sodium salicylate. Moreover, 1 case was referred to me with a slough after injection of quinine and urea; 2 cases where a mixture of sodium chloride and glucose caused sloughing and 1 patient with necrosis after injection of invertose.

The first sign of imminent necrosis is a bleb which forms if the solution is injected superficially, or, a brownish-black eschar which appears when the injection is made, or the solution escapes deeper into the subcutaneous tissues. In the last-named instance, in the beginning the cutis is affected but the epidermis is intact. As long as this is the case an application of any of the popular antiseptics such as mercurochrome, hexylresorcinol or acriflavine and a sterile dressing may be applied in order to prevent a secondary infection. Soon, however, the necrosis works its way to the surface. At this stage hot applications of saturated solution of boric acid, two parts, and alcohol 96 per cent, one part, covered with wax paper, proved to be very beneficial. Not only do they alleviate pain if there is any but they hasten the demarcation of the escharotic tissue. Only one patient complained of considerable pain; the rest described the sensation as smarting; the ulcers seemed to be remarkably indolent. The compresses were applied when the patient stayed home; they were changed every two hours; the rest of the time an indifferent ointment covered the ulcer.

From the moment when the hard, black, adherent necrotic tissue was separated from the underlying raw surface of the ulcer the treatment was directed towards epithelialization of the ulcer. The following procedure proved to be the most successful. The patient is instructed to assume a horizontal position whenever possible and cautioned not to stand on his feet too long at a time. The use of elastic stockings or bandages is not advisable as it interferes with circulation of air and prevents the perspiration from evaporating. For the same reasons only a very thin layer of gauze is applied over the ulcer. Quartz lamp treatments stimulate the granulations but too much expectation from phototherapy may prove disappointing.

Hot applications are discontinued and the patient is instructed to apply twice daily the following well known ointment:

℞ Argent. nitr		0.15
Balsam Peru		1.5
Lanolin		
Petrolat	aa ad	15.0

Scarlet red ointment did not prove as effective as this salve.

Every second day the physician cleanses the ulcer with peroxide of hydrogen and touches the edges and the bottom of the ulcer with 10 per cent silver nitrate solution. If the discharge is profuse, application of pyoktanin blue as a dusting powder helps to check it very promptly.

Many other ointments and powders were tried; it would be rather confusing to enumerate all of them; none gave such satisfactory results as this treatment.

In one case Unna's boot was applied and the patient allowed to walk around. The pain subsided but when after six weeks the boot had been removed the ulcer was somewhat smaller but far from being healed. In subsequent cases I abstained from the use of Unna's boot as it prevents application of any other methods.

It goes without saying that as long as the ulcer is not healed the injections should be discontinued as there is no way to determine the limits of the infection.

An attempt to excise the sloughing area must be regarded as heroic. When the ulcer is covered with healthy granulations and its size is considerable a skin transplantation may be justified but should not be attempted until all necrotic tissue disappears.

[For References see p. 306.]

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The American Journal of Surgery is truly independent and enters into no "entangling alliances." It publishes many papers read before the leading surgical societies of the Country, but it is *not* "the official organ" of any organization. Every manuscript is selected by the editors, as worthy of publication—nothing is published merely because "it was read at the meeting."

EDITORIAL

THE FUTURE OF DEEP ROENTGENOTHERAPY

SHORTLY after the discovery of the roentgen rays, notable success was achieved in *x*-ray treatment of superficial malignancy, but the hope thus inspired in the battle against cancer was promptly tempered by the realization that the type of instruments and tube available were not sufficiently penetrating for serious interference with lesions more deeply seated. The discovery of radium, carrying with it the possibility of introducing powerful foci of radioactivity into the interior of malignant growths through fistulae or through natural body cavities, afforded new means for the direct application of radiation of a wave-length of far greater penetrating power than that supplied by the most powerful *x*-ray installation available until the present time.

Physical investigations made clear that to achieve higher penetrating power with *x*-rays, it was necessary to utilize much higher voltages. Larger treatment areas and cross-fire applications were employed. The skin was guarded against the damaging effects of the relatively useless softer rays by passing the *x*-ray output through a filter, at first of leather, then of sheet aluminum, and finally of heavier metals, such as copper and zinc. Yet measurement of the distribution of the larger deep dose thus obtained showed insufficient uniformity of radiation and much to be desired as to penetration.

It was sought to remedy this defect by utilizing a new principle of distance radiation, placing the *x*-ray tube at a greater distance from the part, an innova-

tion which, because of the inexorable inverse square law, necessitated a very great prolongation of the treatment time to deliver the same amount of depth radiation. However, although the depth effect was much greater and somewhat more ideal, it was still clinically far from satisfactory.

Great progress was being made in instruments; the invention of the hot cathode Coolidge tube, the introduction of stabilizers, the utilization of improved ionization methods of measurements of both superficial and deep *x*-ray intensities, all helped to place deep *x*-ray therapy upon a sound and logical basis.

Meanwhile the thought was gaining ground that even harder radiation than that furnished by *x*-rays might be desirable. Cases were often encountered in which an apparent failure was converted to success by substituting radium for *x*-ray therapy. Radium and its emanation, radon, were placed in needles and in seeds for interstitial implantation, thus bringing the battle against cancer to the phase of hand-to-hand conflict by applying the powerful radiant sources in actual contact with the tissues. Needles and seeds could be distributed almost at will throughout the tumor area, at times aided by surgical procedure to uncover the malignant growth. But this method was found to have serious drawbacks in that the effect was really not a uniform distribution of the radiation; the tissues in immediate contact with the radiferous tubes and needles or seeds received an effect so pronounced as to produce liquefaction necrosis while a short distance away the effect was not even sufficient to depress the growth of the malignant cells. The inverse law was found to be true for all radiation, including that of radium. Careful measurements of radium containers revealed that of one hundred units or radiation delivered to the tissues in immediate contact with the radium, only a small fraction reached the tissues a short distance away. For example, a uterine tumor irradiated by a tube of radium placed in the uterine canal receives an overdose in the immediate vicinity of the radium container and an insufficient dose 3 or 4 cm. away. Tumors treated by radium seeds or needles present on microscopic section a honey-combed aspect revealing these foci of necrosis due to overdosage with surrounding zones of insufficiently irradiated tissues.

Radium therapists have sought to remedy the defects just described by the adoption of the same principle used in deep *x*-ray therapy, namely, "distance radiation"; the radium "bomb" or radium "cannon" was devised to introduce the factor of distance of the part treated from the radiant source, but with the inevitable result of multiplying the milligram-hours of application, according to the law that the intensity of the radiation diminishes inversely as the square of the distance. Radium applications of this distance type involve such large amounts of radium and such prolongation of treatment that doses are talked of in gram-hours instead of milligram-hours. The devotion of a gram of radium to one patient for from ten to thirty or forty hours at once reduces the proportion of patients who may receive the benefit of radium as compared with the multitude requiring it, and even then such methods are practicable only in large institutions endowed with a gram or more of this expensive element. According to figures supplied by the American Society for the Control of Cancer the total amount of radium owned in quantities of 75 mg. or over in the United States is less than 100 gm., an investment worth about six millions of dollars.

Within the last two years a new development in *x*-ray therapy has been seen in the production of apparatus capable of generating still more penetrating rays. Whereas in 1913, when Coolidge put his first tubes on the market, by the expression "deep therapy" one meant a pulsating current with a voltage of 125,000 to 130,000, until recently a voltage of 200,000 was considered the minimum for efficient deep

roentgenotherapy. But now one hears of immense installations with enormous tubes producing *x*-rays at voltages from 500,000 to nearly a million. At least one installation for 900,000 volts is in experimental use at present in the United States with an output of ultra-penetrating *x*-rays equivalent to the gamma rays of an enormous quantity of radium at a fraction of the cost of radium. These more penetrating rays really have a short wave-length comparable to that of the shorter gamma rays of radium, so that German authorities talk of "gammavolt" *x*-ray equipment. With this newest *x*-ray apparatus the distance of the tube from the patient will have to be greatly increased, but this will be compensated for by the greatly improved quality and quantity of radiation. Thus we see promise of achievement of the ideal of an abundance of "gamma" radiation applied at a considerable distance from the part under attack.

No one knows for sure what the outcome will be, but it seems pretty safe to believe that the results will be better. There will of necessity be a period of experimentation with the ultra high voltage instrumentation before conclusions may be drawn. Progress is being made rapidly, and it seems justifiable to anticipate that while radium continues to be more and more in demand for interstitial and cavity application, its use will need to be supplemented by external applications of high voltage reontgen therapy under the newer conditions.

James T. Case.

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MAGENDIE'S SOLUTION

FRANCOIS MAGENDIE was born in Bordeaux, France, in 1783.

His was a place in medical history because he was the pioneer of experimental physiology in France. He used both physical and chemical procedures in his researches. Also he has been referred to as the modern founder of experimenting pharmacology. In anatomy we refer to Magendie's foramen, the foramen which connects the fourth ventricle with the subarachnoid space. He did not have any use for the usual theories employed in his day, but looked upon medicine as "a science in the making." He did not look upon pathology as "the physiology of the sick man." In physiology he strove to further his findings by a closer tabulation of already accepted facts. It has been written that he likened himself to a rag-picker who wandered through the land of science collecting whatever he found. His work resulted in the discovery of only isolated facts. He did not attempt to connect them and he arrived at no important generalizations. He was firm in his belief as to the value of experimentation on living animals. There is no doubt that many of his experiments were done without any ultimate object in view and were truly cruel. Because of this he has had the particular aversion of the anti-vivisectionists.

Magendie founded the first periodical devoted exclusively to physiology, *The Journal de Physiologie Experimentale.* His greatest contributions to science were his experimental proof of the truth of Bell's law, his investigations with the mechanism of deglutition and vomiting, and the effects of excision or section of the cerebellum. He is also known for his researches of the "circus movement" obtained by lesion of the optic thalamus. He demonstrated the cause of the blood flow in the veins due to the pumping power of the heart, that osmosis through the vessel walls is due to the chemical difference between the blood and the lymph, and that the absorption of fluids and semi-solids is a function of the blood vessels as well as of the lymphatics. He early noted that arterial blood pressure rises with expiration.

Magendie introduced bromine iodine compounds, strychnine, morphine, veratrine, brucine, piperine, and emetine into medical practice. He conducted the first experiment in anaphylaxis or supersensitization of the tissues (1839).

He died in 1855 at the age of seventy-three years.

FRANCOIS MAGENDIE

[1783-1855]

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[From Fernelius' Universa Medicina, Geneva, 1679.]

BOOKSHELF BROWSING

THE THINGS THAT MAKE SURGERY SAFE

C. JEFF MILLER, M.D.

NEW ORLEANS, LA.

ALL surgical procedures fall automatically into two great groups, the surgery of necessity and the surgery of election. The surgery of necessity is urgent surgery because it is done for conditions which threaten life. The surgery of election lacks the element of urgency, because, while it adds to the patient's comfort and increases the patient's well-being, it is done for conditions which do not threaten life. Between the two extremes, of course, lie a vast number of diseases, varying from those which will ultimately and inevitably cause death if they are not surgically treated to those in which the probabilities of a serious termination are very remote indeed.

It is perfectly obvious that the surgery of necessity is infinitely more serious than the surgery of election, but it may not be so obvious that in at least one sense the responsibility of the surgeon increases in inverse proportion to the simplicity of the procedure. Let me illustrate. The man with an acute intestinal obstruction, let us say, is doomed to swift and sure death unless surgery is instituted and is instituted without delay. But the woman with a lacerated perineum, let us say, while she may be uncomfortable and while she may become progressively more uncomfortable, stands absolutely no chance of dying if the injury is not corrected promptly, or, for that matter, if it is not corrected at all. But there is still another phase of the problem. The one patient will certainly die if surgery is not done, the other, who certainly will not die if surgery is not done, may possibly die if it is. It is a remote possibility, I grant, but it exists and it cannot be ignored. The one patient has no choice. He must submit to surgery or he must die. He may die in spite of operation, but he will undoubtedly die without it. The other patient, however, must decide for herself whether she would rather endure suffering and inconvenience, secure in the knowledge that it will never be more than suffering and inconvenience, or would prefer to submit to an operation which will cure her disease but which involves a certain degree of risk, a minimal degree, it is true, but still a risk.

I have chosen extreme instances, I admit, but I have done so purposely. I have chosen to illustrate my point by a condition which is inevitably fatal without surgery and a condition which is practically never fatal without it but which may be fatal with it, because I desire to stress as strongly as I

*Read before the sectional meeting of the American College of Surgeons at Oakland, California, April, 1931.

can the responsibility of the surgeon who advises and undertakes elective operations. The man who does emergency surgery—the comparison is not my own—is rescuing a drowning person, whereas the man who does elective surgery, even though he later rescues his victim, first throws him into the water and subjects him to the chance of sinking. It follows, therefore, that it is the bounden duty of the man who undertakes operations of election to render their risk as small as it can be made.

I would say that the first principle of safe surgery is the realization on the part of the surgeon that every operation, especially every abdominal operation, carries with it possibilities of danger which should not be minimized, which cannot be altogether guarded against, and which are appreciated to the full exactly in proportion to the wisdom and the experience of the man who performs it.

It must never be forgotten that it is the patient who pays the price of the surgeon's mistakes. From that law there is no repeal. Indeed, it might be well for us to remind ourselves constantly of a thing that we are in much danger of forgetting in these overly-scientific days, that the center of the surgical universe, if I may so express it, is the patient himself. He is the person chiefly concerned in every operative act. He submits to surgery for one of two reasons, to save his life or to improve his health. He and not the surgeon is the ultimate judge of the success or failure of every operation. To him, surgery is always an evil and he wants to be certain of the necessity for it, not in an abstract case but in his own personal case. He is not grateful for the performance of a perfect technical operation if it does not happen to be indicated for the relief of his particular disease. It is quite possible, from his standpoint, to have as the end-result of surgery a perfectly healed wound and a permanently impaired function.

"When failure occurs in surgery now," says Lord Moynihan, "it is the individual who fails, and not the methods of which Lister has laid the eternal and unshakeable foundations," and Garrison echoes him when he says that Listerian surgery is almost as reliable a science as bookkeeping. The safety of surgery, you see, depends not so much on methods as on the manner in which the individual surgeon applies those methods. The safety of surgery is far more a matter of the personal equation than a matter of details of technique. Let me read you a few sentences which I found the other day in an English text. I do not know who wrote them, but I do know that whoever he was, we may take him to be a very wise and discerning gentleman.

> In the old days, [he says], the master surgeons were of the elect. Only a few were fitted for the work, and they were fitted by reason of their practised dexterity, their knowledge, their judgment, their readiness of resource, and by a hundred fine, brave, manly qualities that make them great men. But today, thanks to the dual blessing of anesthesia and asepsis, every man who determines to be a doctor rather than a linen draper is able to obtain a patient and may tamper with the innermost secrets of the human body to the end that he may effect a cure. It has been made easy for the sons of Aesculapius to take too much upon them.

He is quite correct. It has been made far too easy for the sons of Aesculapius to do as they would in the lines of surgical endeavor. And surgery will never be as safe as it should be until we return to first principles, until we insist that no man shall be permitted to practice it unless he is possessed, unless he proves himself to be possessed, of at least four things, a natural aptitude, adequate knowledge, sound judgment, and that quality which, for lack of a better name, we call the surgical conscience.

I am far from believing that good surgeons cannot be molded out of most unpromising clay, for I have seen the miracle happen many times, but I have never seen a man become a good surgeon who did not have at least some natural aptitude. I have never seen a man, whatever his other qualifications, become a good

surgeon who did not like to do things with his hands, who did not know how to use his hands swiftly, gently and surely. We are fond of saying, and we are quite correct in saying, that there is more to the practice of surgery than mere craftsmanship. But let us not forget the tremendous importance of craftsmanship. The surgeon must do his work swiftly and accurately, he must, in his actual performance, as Lord Moynihan says, make of surgery a merciful art. The fact that under anesthesia operations can be done deliberately today must not be construed to mean that time is of no consequence. Time is of very great consequence. An operation that is unduly prolonged increases the patient's risk and is usually a very clear indication that the surgeon who is doing it frankly does not know the mechanical part of his task. I have heard in a half dozen forms, as I am sure all have, the story of the interne who was asked by a visiting doctor what was the difference between the widely variant results obtained for the same operation by two very prominent surgeons who operated in that special hospital. And the interne, it will be remembered, whose discernment must have been vastly greater than his tact, replied promptly that the difference was about thirty minutes. That is a story that could be well taken to heart and pondered by us all. The tissues of the human body can be insulted up to a certain point; after that point the retribution is swift and sure, and the surgeon who does not know how to be dexterous will do well to remember that fact.

In the second place, surgery is not safe unless the surgeon knows not only how to cut but also when to cut and where to cut. We have a right to take for granted that he possesses certain general knowledge; we ought also to have a right to take for granted that he possesses a detailed knowledge of surgical anatomy. For more than twenty-five years I have been preaching to students, without ceasing, and, I regret to say, without any very noticeable effect, that the only way to learn surgical anatomy is to learn it on the cadaver. The pathology of the living must be studied on the living subject, but surgical anatomy can be learned only at the autopsy table and upon the cadaver.

I should regard it as a mighty step forward if the American College of Surgeons should add to its requirements for admission to fellowship the requirement that every candidate present evidence that he had taken a course in cadaveric surgery, and that he had taken it under the supervision of an expert in that field. If such a requirement were made a prerequisite to the practice of surgery, it would work no hardship to the profession and it would work untold good to the victims of our surgical endeavors. It would sweep away forever the type of surgery which I can only call experimental, which is done so generally today and which merits our unqualified condemnation.

The man who is trained in surgical anatomy knows, immediately he opens the abdomen, the significance of what he sees before him. He knows the location, both absolute and relative, of organs and nerves and blood vessels, of muscle planes and fascial sheaths. He realizes that every individual differs in the details of his bodily structure, and that knowledge, when he is working in the neighborhood of vital organs and blood vessels, may mean the difference between life and death for his patient. He begins his work, not with a casual manipulation of whatever structure first meets his inquisitive fingers, but with a systematic identification of landmarks, an orderly inventory, as it were, of normal and abnormal conditions. He is a safe surgeon, I say again, because he knows his way about the field in which he does his work.

The man who possesses this knowledge and who uses his hands well is, whatever his other deficiencies may be, an outstanding surgeon. My secretary has long contended that even an untrained lay person could walk into an operating room

and tell within a few minutes whether the surgeon handling the case were competent or incompetent. I used to question her contention, but I have come to believe that she is correct: it does not take any specialized knowledge to comprehend whether or not a person engaged in a mechanical task knows what he is doing and is doing it as it should be done.

But surgery which stops at this point is not safe surgery. Craftsmanship is of little worth, knowledge is of little worth, unless they are allied with surgical judgment. Now surgical judgment is partly based upon intuition, but it goes far beyond it. It is surely based upon knowledge. It is surely based upon wisdom, which is the application of knowledge. And it is chiefly based upon experience, which is the interpretation of what we have seen and done and thought, or the interpretation of what others have seen and done and thought and we have been wise enough to profit by. If, as some cynic has said, experience is the name we give our mistakes, it is likewise, if we are receptive, the touchstone by which we interpret life, and surely it is the foundation stone of judgment.

Finally, no surgery can be safe unless the surgeon who performs it adds to his other qualities of mind and heart the greatest of them all, the thing that we call the surgical conscience. One need not necessarily operate in order to possess it. It is possessed in fullest measure, I would say, by the men who would like to be surgeons but who are not because they are honest enough to admit to themselves their lack of fitness for the task. It is the quality which makes the surgeon unwilling to operate until he is sure in his own mind that his training is adequate and his skill is sufficient for him to dare to lay hands upon the human body. It is the quality which makes him more than willing, which makes him eager, to accept the guidance of the man who knows more than he does of special diseases and special procedures. It is the quality which makes him call for assistance promptly and freely when he sees himself drifting beyond his depths. It is the quality which stays his hand from unnecessary surgery, which drives his hand to the surgery of desperation, the surgery that sullies his record, as he knows it cannot fail to sully it, but that gives to dying men and women their only chance of salvation. It is the quality that makes him realize the high seriousness of his calling, that makes him earnest in his purposes, honest in his mental processes, steadfast in his endeavors, courageous in the tribulations that are the inevitable lot of the physician who has chosen to be a surgeon.

Matters of technique are important, but they need not be emphasized to the surgeon who possesses the qualities I have just named, natural aptitude, knowledge, judgment and the surgical conscience, for if he possess them, he cannot fail to possess their fruits. Safe surgery is not a matter of chance any more than it is a matter of complex details. It is first and foremost a matter of sound principles, a matter of the application of sound principles, and the responsibility of their application is the responsibility of the individual surgeon. Let him see to it, then, that he is what he should be, that he does what he should do, for upon his shoulders rests the heavy task of making surgery safe.

BOOK REVIEWS

SIXTY CENTURIES OF HEALTH AND PHYSIK. By S. G. Stubbs and E. W. Bligh. With an Introduction by Sir Humphry Rolleston, Bart. 253 pp. New York, Paul B. Hoeber, Inc., 1931.

To describe the history of medicine acceptably in a few hundred pages is in itself a very considerable achievement; but to prepare a book on the subject containing many fresh facts presented in a fashion appealing both to lay and medical readers is a circumstance deserving of some comment. The point of view of the authors is detached and refreshing and the text has throughout a literary flavor and light touch which makes it singularly attractive.

The first ten and the nineteenth chapter are by Mr. Stubbs, who draws freely upon his intimate knowledge of modern archeological research. He draws attention to the ironical fact that the earliest human remains, *i.e.*, *Pithecanthropus erectus*, suffered from a modern malady. Mr. Stubbs is evidently much interested in the history of hygiene and sanitation and he gives us a most illuminating account of the sanitary system found in the Mesopotamian district 4000 B.C. and in Rome and the Roman colonies. His account of Greek and Roman medicine is excellent and can be warmly recommended. He falls into the common error, however, of describing Galen's given name as Claudius, the *Cl.* in reality standing for Clarissimus.

Bligh is responsible for the second half of the book, Chapters XI to XVIII and XX. He begins by telling the story of The Royal Society and presents a vivid picture of all the scientific ferment of the period of The Restoration. Bligh would seem to have a nodding acquaintance with all of the chief personalities and he refers to each of the early members of The Royal Society as old friends. The most notable section in the book is Chapter XIII, The Microscope and the Discovery of Germs. This represents a first rate contribution to medical history and contains a number of new and important facts relating to the early history of the germ theory. Kircher's description of "the little worms that cause the plague," excellently translated by Mr. A. M. Muirhead, makes it evident that the learned Jesuit is entitled to an important place among the early writers on the germ theory. The most interesting disclosures, however, are the passages from Marchmont Needham's "Medela Medicinae"; Needham seized upon Kircher's theory and seemed to appreciate its far-reaching significance. The account of Sydenham in Chapter XIV is very happy and the chapter on the Eighteenth Century is also very well done. The book can also be recommended for its wealth of well chosen illustrations (64 full-page plates), very few of which are encountered in any other history of medicine.

NASENPLASTIK UND SONSTIGE GESICHTSPLASTIK, NEBST EINEM ANHANG UBER MAMAPLASTIK EIN ATLAS UND LEHRBUCH. By Prof. Dr. J. Joseph. 3 vols., Leipzig, Curt Kabitzsch, 1931.

Dr. Joseph's monumental atlas on plastic surgery is now complete. Part I appeared over a year ago. Parts II and III just published, complete the work.

The subject of plastic surgery of the face and of the breast is covered in a most satisfying manner. Over 1718 splendid illustrations, many of which are colored, depict each operation, step by step. The accompanying text is clear and authoritative. Every man doing any plastic surgery should have this book available and even those who cannot read German will find the illustrations of extreme value. The subject is covered with true German thoroughness. Even the historical aspects are considered and the reproductions of illustrations from the famous work of Tagliacozzi (Venice, 1597) are splendid. The results obtained by the author are quite remarkable as demonstrated by the "before and after" pictures. The work is divided into general and special parts, the first taking up the general and anatomical and artistic aspects of plastic surgery. The second or special part takes up the pathology and the classification of deformities along pathological lines.

Commendation must be added for the quality of the illustrations. It would indeed be difficult to improve upon them and even the severest critic will admit that not any of the 1718 illustrations should be omitted. There is no evidence whatever of padding and there is not the annoying number of illustrations of special instruments that so often mars works

of this kind. It is interesting that many of the cases illustrated were as long as ten years after the operation. This is a work of which the author and the publishers may well be proud and no surgeon will regret the time given to its study.

Accidental Injuries, The Medico-legal Aspects of Workmen's Compensation and Public Liability. By Henry H. Kessler, A.B., M.D., F.A.C.S., F.A.P.H.A., 698 pp., Phila., Lea & Febiger, 1931.

This book takes up the legal end of disabilities and any physician having to testify in court or before an arbitration board will find it of extreme value for reference. With many years of experience as head of the New Jersey Rehabilitation Clinic, Dr. Kessler is almost in a unique position to write this book and every page of it has the benefit of his tremendous experience.

The Rational Treatment of Varicose Veins and Varicocele, with Notes on the Application of the Obliterative Method of Treatment to Other Conditions. By W. Turner Warwick, M.A., M.B., (Cantab.), F.R.C.S. (Eng.), 176 pp., London, Faber & Faber, Ltd., 1931.

This book is best described in the opening paragraph of the author's Preface: "These teachings are based on the results of investigations primarily undertaken to find answers to a few of the occasionally irritating, sometimes stimulating, but ever persisting whys of medical students. They have stood the test of my own practice for three or four years, and are now presented in the hope that they may prove of service to the practitioner who has met with the same difficulties."

Well and concisely written, the work covers the ground intended in a very satisfactory fashion.

Progressive Medicine, A Quarterly Digest of Advances, Discoveries and Improvements in the Medical and Surgical Sciences. Edited by Hobart Amory Hare, M.D., LL.D. Assisted by Leighton F. Appleman, M.D., 339 pp., Vol. 2, Phila., Lea & Febiger, June, 1931.

The June 1931 number of Progressive Medicine arrived simultaneously with the news of the passing away of the Editor, Dr. Hobart Amory Hare. This volume, therefore, is of a special interest as being the last under the editorial direction of the founder of this splendid series. It contains the following articles: Hernia, Surgery of the Abdomen, Exclusive of Hernia, Gynecology, Disorders of Nutrition and Metabolism; Diseases of the Glands of Internal Secretion; Diseases of the Blood and Spleen, and Ophthalmology, each of which is a concise, thorough and up-to-date discussion of the subjects covered. This quarterly review has been a welcome visitor for a great many years and it is hoped that a new Editor will be found to keep it up to the high standards set by Dr. Hare.

Operative Surgery, General and Special Considerations. By Dr. Martin Kirschner, Professor of Surgery and Director of the Surgical Clinic at the University of Tubingen (Germany). Authorized translation by I. S. Ravdin, B.S., M.D., 642 pp., 746 illus., mostly colored. Phila., Lippincott, 1931.

In taking up this volume one is first of all impressed by the remarkable wealth of splendid illustrations. In less than 700 pages there are over 700 illustrations of as fine a grade as we have seen in any medical publication. The volume is by no means a textbook or practice of surgery. It is an operative surgery for the practicing surgeon divided into eleven chapters as follows: I. This takes up the question of the Operating Room, The Operator and His Assistants, The General Examination and Management of the Patient, Position of the Patient During the Operation, and General Principles of Operative Technic. II. The Control of Pain, General Anaesthesia, Local Anaesthesia, Venous Anaesthesia, and Spinal Anaesthesia. III. The Control of Infection, The Aseptic Operation, Aseptic Technic of the Operative Set-Up and of the Wound, Conduct of the Operation in an Infected Field—Primary Care of Traumatic Wounds, Operative Management of Local Infection, and Changing of Dressings and the Further Care of the Wound. IV. The Control of Hemorrhage, Arrest of Bleeding, and Treatment After Hemorrhage. V. Operations on the Skin and Subcutaneous

Connective Tissue, Incision, Union and Transplantation of Skin, Surgery of the Skin and of the Subcutaneous Tissue, and Restoration of Contour by Tissue Transplantation and Paraffin Injection.

VI. Operations on Muscles, Tendons and Fascia, Division and Suture of Muscles and Tendons, Lengthening and Shortening of Muscles and Tendons, Transplantation of Tendons, Construction of Artificial Tendons, Free Transplantation of Fascia and Tendons.

VII. The Surgery of Bloodvessels, Management of Congenital Vascular Tumors, Vessel Suture, Surgical Treatment of Aneurysms, Arteriotomy, and Treatment of Varicose Veins. VIII. Operations on the Nerves, General Considerations, Resection and Suture of Nerves, Management of Nerve Defects, Treatment of Pathologic Irritability of Nerves, Periarterial Sympathectomy. IX. Bone Surgery, General Principles, Bone Surgery, Open Operations for Fractures and Pseudarthrosis (Non-Union), Management of Defects of Bone, The Correction of Bony Deformities, Nail and Wire Traction, Management of Bone Tumors, and Treatment of Osteomyelitis. X. Operations on Joints, General Considerations, Arthrotomy-Management of Wounds and Joints, Aspiration of Joints, Drainage of Joints, Excision of Joints, Arthrodesis-Artificial Production of Ankylosis, Arthroplasty-Operative Mobilization of a Joint.

XI. Amputation and Disarticulation, Introduction, The Site of Removal, Incision of the Soft Parts in Amputation and Disarticulation, Care of the Bone, Care of the Vessels, Care of the Nerves, Reamputations and Secondary Plastic Operations, After care of the Stump, Kinoplastic Amputations, and Index.

The text is well written without any waste of words and covers the ground in a masterful fashion. It is one of the most practical books we know of for the general surgeon. No attempt is made to cover all the different operations in each instance, but the operations of the author's choice are given in detail with reference to a few other methods in almost every instance.

Both the Translator and the Publishers are to be congratulated on making this book available to English readers.

Abdominal Pain. By John Morley, CH.M., F.R.C.S. With an introduction by J. S. B. Stopford, M.D., F.R.S. 185 pp., New York, William Wood, 1931.

This is as interesting a discussion of pain in the abdomen as we have yet seen. The author has made a thorough yet concise study of the subject and has reached conclusions which are entitled to thoughtful consideration even though they may not meet with a complete acceptance in all cases. As Dr. Morley says in his Preface, "The book is mainly the result of personal clinical observations, and has no pretence to be an encycolpaedic work of reference. It is inevitably controversial in tone, and limited in scope to the field in which a general surgeon has opportunities for study."

Chirurgie de L'Ulcere Gastrique et Duodenal. By N. Hortolomei and Butureanu. 407 pp. Paris, Masson et Cie, 1921.

In this book of 407 pages the authors review most of the operations which have ever been devised for the relief of ulcer. The book will perhaps be of greater value to the student of the history of the subject than to the abdominal surgeon who is always looking for hints in regard to technique. There is a good bibliography which is very helpful, and there is considerable discussion in regard to the respective merits of medical and surgical treatment of ulcer. Considerable space is devoted to the complications which sometimes follow operations for ulcer. There are valuable chapters on the changes which occur in the physiology of the stomach and bowel following the various operations for ulcer.

Altogether it is an attractive and a useful book for the library of the gastroenterologist and the gastric surgeon.

Die Bakteriologie der Wurmfortsatzentsündung und der appendikulären Peritonitis (Bacteriology of Appendicitis). By W. Löhr und L. Rassfeld. 105 pp. Leipzig, Georg Thieme, 1931.

It would be a brave man who would attempt to write something new about the bacteriology of appendicitis. Much has been done in the past, but techniques are constantly being improved and often a subject which appears to have been exhausted can be gone over again with profit. The intestinal flora of a normal appendix contains large amounts of B. coli, B. lactis-aerogenes and pneumobacteria Friedländer, also B. Welchii. There are large numbers of streptococcus acidi lactici and actinomyce-

tum which are perhaps not pathogenic. Occasionally a normal appendix is free from bacteria. The diseased appendix, even when full of pus, often contains the same bacteria that are found normally. With very severe infections there are even fewer bacteria present than are usually found. In gangrenous appendicitis the actinomycetum may dominate the picture. The writers believe that appendicitis is produced by bacteria which are always present, but there is a possibility that sometimes streptococci may arrive by way of the blood stream.

The monograph is well illustrated and there are protocols of the findings in 131 cases.

Polyposis Gastro-intestinalis. By Hans Tønnesen, *Acta. Chir. Scandin.*, 68: 1–224.

This is an interesting monograph based on 40 cases of polyposis of stomach or intestine. The writer believes that the etiology is based upon a combination of hereditary and chronic inflammation. Actually, the writer might have brought out more clearly that there are three main types of polyposis of the colon; one in which the peculiarity is hereditary and perhaps congenital, another in which the cause is chronic ulcerative colitis, and a third in which the etiology is unknown.

Tønnesen believes that in 65 per cent of the cases of carcinoma of the colon the disease began as a polyp. He believes that gastric polyposis is based on a chronic gastritis. Polyposis of the digestive tract occurs twice as frequently in men as in women. The commonest symptoms are diarrhea, intestinal bleeding and pain in the lower part of the abdomen. Treatment in most cases must obviously be surgical in nature.

There is a bibliography, but no index.

PRINCIPLES OF PREOPERATIVE & POSTOPERATIVE TREATMENT

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PRINCIPLES OF PREOPERATIVE & POSTOPERATIVE TREATMENT

Chapter XII

THE TREATMENT OF OPERATIVE WOUNDS

The treatment of operative wounds is a task from which there is, of course, no escape for the medical attendant who allies himself at all with the practice of surgery. The actual surgical wound itself is naturally frequently only a means to an end and to that extent can be considered as a matter of relatively minor importance. Usually in major surgery the acutal site of pathology is exposed only once, while the patient is on the operating table, and thereafter is covered by tissues of varying thickness, the only apparent remnant of the manipulation being, in the average case, a mere skin incision. To the patient, the care of the external incision is of the utmost moment, as it represents to him, on the one hand, a source of possible temporary pain, with exacerbations at times of dressing, and on the other hand, a possible source of permanently embarrassing disfigurement. The day of unduly small skin incisions in surgery has largely passed and, as there can be no doubt that a large incision holds more possibilities than a small one for pain as well as ugliness, the medical attendant will do well to perfect himself in those matters which make for the relative comfort of the patient during redressings and for the assurance of a cosmetic effect after healing has occurred as satisfactorily as can be expected under the circumstances. However, neither the matter of comfort to the patient nor the matter of an ultimately good cosmetic effect is the essential desideratum from the medical point of view in any surgical case, but rather the reestablishment of good physiological function, and this especially as it concerns affairs in the depth of the wound.

1. Normal Process of Repair in Wounds

In order to care for surgical wounds intelligently it is essential to understand the characteristic changes which occur in such wounds during the process of healing. It has been customary for years to consider in this connection two types of healing: (A) healing by first intention and (B) healing by second intention.

A. Healing by First Intention: Healing by first intention characteristically occurs in cleanly incised, non-contaminated wounds in which the wound edges have been accurately apposed, and accurate apposition of edges is adequately maintained subsequently. The first histopathological change which can be noted consists of a liquefaction necrosis of such cells as have been devitalized by the operative trauma; this necrosis is minimal and involves merely a thin sheet of cells, both those actually lining the incision and those lying immediately adjacent to the exposed surface. This reaction may be noted within an hour of the time of infliction of the wound, and is accompanied by a retraction of elastic tissue fibrillae from the wound surfaces; the severed blood vessels, being rich in elastic tissue, undergo particularly marked retraction. Due to the opening of lymph and blood vessels there is also, during this period, an outpouring of blood and lymph elements into the wound; the amount of blood elements extravasated should be minimal provided that adequate hemostasis has been secured at the time of operation.[1] At the end of about eight hours the degenerative reaction just described has become maximal, the blood elements have undergone coagulation, and the process of repair begins with the proliferation of epithelial cells across the skin surface and the invasion of the blood clot by connective tissue fibroblasts in the depths of the wound. Vascularization of the new connective tissue occurs by a process of budding of the capillaries adjacent to the wound surfaces, these capillary buds invading the blood clot and eventually bridging the gap made by the incision.

By the end of four days epithelization of the wound surface has ordinarily become complete, and by the end of six or seven days vascular and cellular tissue has replaced the clot between the two wound edges, the debris incident to the autolysis of the blood clot, which is formed in the interim, having been removed by the phagocytic action of the mononuclear leucocytes. Only at the end of approximately three weeks, however, has the process of scar formation become quite complete.

B. Healing by Second Intention: The process of healing by second intention is not essentially different from the foregoing. It applies to wounds which have involved the devitalization of considerable tissue or in which the wound edges have not been accurately apposed originally, or in which they have been insecurely supported in such a position subsequently. In the healing of such wounds the formation of granulation tissue, with its typical capillary loops, is a dominant part of the picture. This granulation tissue invades such blood clots as may form, and in cases in which the blood clot does not completely fill the hiatus between the wound edges, the granulating wound edges progressively grow toward one another and ultimately fuse. By the third or fourth day granulation has usually formed to such an extent as to have formed a bridge of tissue over which epitheliazation begins to take place from the edges of the wound surface.

The characteristics of such wounds when fully healed are the presence of considerable amounts of scar tissue and the absence in the scar of the usual skin appendages, sweat glands, sebaceous glands and hair follicles.

II. The Care of Ordinary Surgical Wounds

In clean surgical cases in which primary suture of an incision has been performed without the use of drains or other material surgical expedients, little can be accomplished by the medical attendant as far as the wound is concerned beyond (1) the prevention of infection, (2) the early recognition of

such complications as may occur, especially hemorrhagic or serous accumulations, either obvious or occult, and the occurrence of unavoidable infection, and (3) the prompt and proper removal of suture material as soon as the indications for such removal become manifest.

A. The Omission of Gauze Dressings Following Abdominal Operations: A number of operators have recently been advocating the omission of all gauze dressings following the closure of abdominal incision in clean cases. The wound is simply allowed to come into contact with the air, being protected from contact with the bedclothing by means of a wire cradle, and healing takes place, according to many observers, more kindly under this form of treatment than in those cases in which gauze is applied. The method has probably not been used extensively enough to permit of its just evaluation, but certainly it is difficult to see how contamination of the operative wound can be avoided in all cases under such a regime, and although theoretically not unsound, the method would seem to present serious practical difficulties, at least as a routine procedure.

B. Performance of Routine Surgical Dressings: 1. *The Importance of Sterility:* For at least the first four days following operation in the case of the so-called "clean" or non-infected wound which proceeds to healing by primary intention and often for considerable longer periods in wounds that for one reason or another remain open, it becomes incumbent upon the surgical dresser to use, theoretically at least, the same aseptic precautions that were used in the operating room at the time the original dressing was applied. Actually this would mean at least a five-minute period of scrubbing the hands and the subsequent donning of sterile gown and rubber gloves. Such a procedure would consume, on the one hand, so much time, and on the other, so much surgical material that in the routine case it becomes impracticable. Furthermore, it is usually unnecessary, as the manipulations ordinarily made during the course of dressings are much simpler than those originally

made in the operating room and can be performed by the intermediation of instruments, It should be taken as a working principle, however, that in the early postoperative manipulation of wounds every redressing is actually an experiment in bacteriology precisely as was the original operating room technique, and in those cases in which, because of the complexities of manipulation required, it becomes no longer possible to use the intermediation of sterile instruments, the more arduous but safer method of operating room technique should, and must, be used. If it is decided in a given case that it will be possible to make all manipulations without touching any part of the wound or dressings with any unsterile object, the medical attendant should at least not proceed to his task without replacing his street coat with a clean hospital garment and giving his hands a thorough washing with soap and running water. Furthermore, when the dressing has actually been completed, and before one proceeds to any other task whatever, especially to the dressing of another case, the hands should again be thoroughly washed. This much is an esthetic as well as a surgical requisite, and any lapses in this part of the technique are apt to be appreciated quite as much by the patient as by one's professional associates. The pouring of alcohol on the hands subsequent to cleansing with soap and water is an added precaution in the interests of safety both to one's self and one's patients which may bring rich, even if unrecognized returns.

Instruments should be presented to the surgeon carefully sterilized and preserved from contamination either in a solution of alcohol, lysol, or other suitable antiseptic, or else dry and protected by a sterile towel or other dry container. Their sterility should be respected, the dresser directing that they be removed from the solution, or dry container, for him by means of sterile forceps, he, in turn, grasping them only by their handles and immediately discarding them in favor of new sterile ones if for any reason the working parts of the instruments become contaminated. The practice of taking instru-

ments from antiseptic solutions directly with the fingers or of returning them after use to solutions or receptacles, which, in turn, contain sterile instruments, or the handling of dressings directly with the ungloved hands, especially the removal of them from sterile bundles or wrappings, is a procedure mentioned only to be condemned.

Nothing so breaks the morale of sterility in a hospital as carelessness in the matter of postoperative surgical dressings, and it would be worth while to exercise the utmost care in this particular part of a surgeon's work for its salutary effect on the nursing staff alone if for no other reason.

2. *Removal of Adhesive Plaster and Dressings:* The removal of adhesive plaster from a person's skin need not be a painful procedure if time be taken to soften the adhesive side of the plaster, as it is removed, with a little ether, gasoline, benzine, or other suitable solvent. Of course, most of the pain of removal in any case is due to traction on hairs, and as shaving of the environs of an operative wound is universally practiced previous to operation, undue inconvenience to the patient should not ordinarily result from this source. Occasionally, especially in the presence of infection, really acute pain may result from indirect traction on the wound edges during the removal of plaster, but usually a little common sense in applying the force required to peel the adhesive away from the skin will be all that is needed to obviate this. With a little manual dexterity and practice, plaster may be painlessly removed by a quick pull without previously softening it, the latter process being usually reserved for use in the case of unduly sensitive and apprehensive patients. Often the removal of a surgical dressing can be delegated to the attending nurse after the surgeon has washed his hands and is ready to proceed with the actual redressing, but when there is any doubt as to the nurse's ability to remove dressings properly, it may be necessary for the surgeon to loosen the dressings himself before he proceeds to the final preparation of his hands, and subsequently to

removing the dressings with forceps, which, of course, are immediately discarded along with the dressing.

3. *Reapplication of Dressings:* In reapplying dressings to operative wounds the following principles should be respected:

1. The dressing should be voluminous enough to absorb the secretions from the wound over a reasonably long period of time without becoming soggy. Obviously the secretion from certain wounds will be more profuse than from others, and some wounds will require more frequent dressings than others; hence, a certain amount of judgment will be required in selecting the proper bulk of dressing material for the individual case.

2. The dressing should not be more voluminous than necessary to meet these indications, for bulky dressings must almost of necessity be more or less uncomfortable, and especially in the summertime and in a warm climate, may, in addition, become an actual menace through the accumulation beneath them of perspiration, which is always contaminated by skin bacteria.

3. The dressing should be applied neither too tightly nor too loosely; if too tight it will be uncomfortable to the patient, and, in addition, it may be actually injurious because of interference with the blood supply to the part, respiration, or some other important local or general function. If too loose it readily becomes dislodged, and thus fails to perform its protective function properly.

4. The dressing should be so applied as to discourage attempts on the part of the patient to manipulate it. Most dressings, for this reason, are best covered securely with adhesive strips; in certain cases these may completely cover the wound, being imbricated from below upward, the lower strips being applied more tightly than the upper ones in the case of abdominal incision, where support is required below and freedom of respiratory motion above.

With respect to the proper time for changing dressings no absolute rules can be formulated, but the following suggestions may be offered:

1. In the case of the average clean laparotomy wound, except in unusually warm weather, it is generally unnecessary to disturb the original dressing until time for the removal of stitches; soiling of the dressing by perspiration, or otherwise, is, of course, an indication for earlier dressing. There is something to be said, however, in favor of a change of dressings even in clean cases about the third or fourth day, and such a procedure is adopted routinely by certain authorities; in this way early suppuration, minor

degrees of vascular oozing, and malposition of wound edges which would otherwise pass unnoticed may sometimes be detected and rectified or controlled by the institution of appropriate treatment.

2. In the case of wounds from which exudation is taking place dressings should be changed as often as may be necessary to prevent sogginess; dressings which have ceased to be absorptive through accumulation of secretions have ceased to function as a dressing and have become an undesirable kind of poultice. Daily dressing will suffice in many cases; more frequent, even hourly, dressings may occasionally be required in others.

4. *Surgical Drainage and the Care of Drainage Material:* The indications for the use of drains and drainage material in the treatment of surgical conditions are interpreted much more conservatively now than formerly; for this reason, and also because disease is being diagnosed and subjected to operation earlier than previously, only relatively few cases nowadays present postoperative problems associated with the care of surgical drains.

This statement is true of all surgery, but it is particularly true of abdominal surgery, in which, for instance, drainage of the gall-bladder bed after cholecystectomy is now perhaps as exceptional as formerly it was universal, and many excellent and seasoned surgeons do not hesitate to close an abdomen tightly even in the presence of generalized suppurative peritonitis.

Drains of one variety or another are used for the following purposes:

1. To relieve pressure, especially pressure within a hollow viscus, such as the urinary or gall bladder, or some part of the intestinal tract,

2. To initiate an irritative process designed to favor the formation of adhesions or rarely to induce erosion of tissue,

3. To facilitate the evacuation of infected or toxic material.

a. Rubber tube drains: The use of glass, metal, or other tubing made of hard, unyielding material for purposes of drainage, is at the present time virtually obsolete; such material has a distinct tendency to produce local pressure

necrosis and when used, for instance, in the abdomen is likely to erode either into the lumen of some part of the intestinal tract or the lumen of some sizeable blood vessel, either of which events might prove more or less rapidly fatal. Glass presents an added danger in that it is breakable, and, though the danger of breakage is somewhat remote under ordinary circumstances, the result of such breakage would so inevitably prove catastrophic that the very thought of it should act as an effectual deterrent to the employment of such a substance.

Soft rubber tubing presents the danger of pressure necrosis in less degree than harder materials, though it is not entirely immune to this undesirable effect. The objection to rubber tubing as drainage material chiefly consists in the fact that it is ordinarily inefficient except for relatively short intervals of time. In case dependence is placed on the terminal opening of such a tube, the lumen readily becomes blocked by flakes of fibrin, by the surface of an adjacent organ, or in the case of abdominal drainage by the omentum. For this reason rubber drainage tubes before use are usually perforated along the sides, split along one side, or cut in spiral fashion, so that even though one avenue of exit may become blocked others may remain patulous. Practically, these expedients improve the situation only slightly.

When using rubber tube drainage it is also important to realize that the efficiency of such drainage depends almost entirely, even under the most favorable conditions, on gravity; fluids do not ordinarily discharge uphill through the lumen of a tube, and consequently in order to obtain maximal advantage from such a device relations must be adjusted so that the tube pursues a progressively downward course. This involves care in the original disposition of tubes, but more particularly care in the postoperative position of the patient.

Rubber tubes which are designed to promote drainage and which do not continually discharge drainage material, must in all cases be manipulated unless one can assure oneself (1) that no blockage has occurred and (2) that material requiring

drainage will not subsequently reaccumulate. Under certain circumstances rubber tube drains may be removed, cleaned and sterilized, and reinserted; but this obviously does not apply to tubes inserted through the abdominal wall or tubes inserted in other regions in which the reinsertion of the tube cannot be performed entirely, or at least largely, under the control of direct vision. Usually the expedient adopted in attempting to clear a tube which has become blocked is one of partial withdrawal. Before attempting such a maneuver, however, one should be certain that any sutures of absorbable material which may have been used to anchor the tube *in situ* have become liquefied, that traction on the tube will not rupture or dislodge important structures, and that portions of the drain will not tear away. These considerations are particularly important in attempting the removal of drains in and about the bile ducts, not only because of the nature of the structures involved, but also because of the depth of these structures from the skin surface.

Rubber tubes when used for purposes of intraperitoneal drainage and when undisturbed are of no further value after a period of twenty-four hours, because within such a period plastic adhesions will surely have been formed to such an extent as to have walled them off completely. The period of effective drainage can often be prolonged somewhat in these cases by withdrawing the tube an inch or two at a time at intervals of several hours, possibly rotating the tube gently during the process of withdrawal; the process of withdrawal can usually be begun within from twelve to twenty-four hours postoperatively.

Rubber tube drains should invariably be provided with some safety attachment to prevent them from inadvertently slipping completely out of sight into the wound; the device commonly used is a safety pin passed through the tube and fastened just beyond the skin surface.

Perhaps the most frequent use of the rubber tube drain at the present time is in drainage of the pleural cavity; for

this purpose it is not unsuitable, as dependent drainage can be induced, tubes can be removed, cleaned, and reinserted without much difficulty and with comparative safety, and the frequent combination of drainage with Dakinization of the pleural cavity tends to maintain the patency of the lumen of the tube.

b. Gauze drains: As a drainage material gauze has been increasingly falling into disfavor during recent years; this is primarily because gauze becomes rapidly soaked with secretions, and once it has become thoroughly impregnated promptly ceases to serve its original function and tends to become a culture tube for bacteria and a plug to prevent fluid accumulations from reaching the surface. The interstices of the fabric become clogged with cellular elements and fibrin, and the rough surfaces presented by the strands of cotton fibers produce irritation of the wound surfaces with which they come in contact. For the latter reason gauze acts as an excellent medium for the stimulation of adhesions and is sometimes inserted into wounds primarily for this purpose rather than for drainage; a gauze pack or drain placed against the parietal pleura will within twenty-four or thirty-six hours cause the visceral and parietal pleurae to adhere firmly together, and a tuft of gauze allowed to protrude from the end of a rubber drain and placed extraperitoneally to an appendiceal abscess will within forty-eight hours cause erosion of the peritoneal wall of the abscess so that the abscess will rupture and discharge its contents along the drain.[2]

Except on very rare occasions and for very special purposes, like the one just mentioned, gauze should not be allowed to remain in wounds longer than twenty-four hours and only rarely for periods longer than twelve hours.

d. Modified gauze drains: The primary advantage of gauze as a drain lies in its tremendous capacity for capillary attraction, and its consequent ability to provide drainage against gravity, so that the relative position of the patient and the drain does not necessarily have to be such as to produce

dependent drainage. Attempts have been made to combine the advantages of gauze and rubber tubing by placing a roll of gauze within the tubing, or by rolling gauze in a sheath of rubber dam (cigarette or Penrose drain) which amounts virtually to the same thing except that the latter form of apparatus is much more pliable, and consequently not so prone to produce pressure necrosis. When making use of such appliances it should be remembered, however, that the same general principles apply as in the case of gauze alone, and a piece of gauze thoroughly soaked with secretion and possibly also impregnated with bacteria is no more desirable in a wound when enclosed in a piece of rubber than when not so enclosed.

A modification of the Mikulicz gauze drain has been recently used with success; this drain finds its widest usefulness in connection with the treatment of diffuse peritonitis. The original (usually abdominal) incision is left wide open and over it is spread a large piece of rubber dam in which has been previously cut multiple small openings; gauze is now packed into the wound by depressing the piece of rubber dam until the abdominal opening is thoroughly filled and the wound is spread widely.

The value of such a drain is confined to the earliest postoperative hours, and as soon as the gauze has become thoroughly saturated with secretion it should be promptly removed. It should be refilled only in case drainage has been very profuse and fibrin is believed not to have walled off the drain sufficiently to make further drainage impossible.

d. Simple rubber dam drains: Possibly the simple rubber dam drain or some modification of it most commonly meets the need of postoperative drainage. A folded or rolled piece of thin rubber presents a smooth surface for contact with wound surfaces and thus produces a minimum of irritation; it is soft and pliable and consequently shows little tendency to the production of pressure necrosis; its surfaces being in close contact capillary attraction is favored and drainage is not solely dependent upon gravity; it can be readily cut and shaped in

accordance with the particular conditions to which it may be applicable.[3]

5. *The Removal of Stitches:* The question of the proper time for the postoperative removal of sutures can be settled only by a consideration of the functions which the latter are designed to perform and the particular conditions present. Two general types of skin sutures are in use at the present time: (1) the superficial or *coaptation suture* which is introduced fairly near to the edge of the incision, its function being to bring the cut edges of the skin into as accurate approximation as possible and thus avoid unnecessary scar formation, and (2) the *deep, relaxation or retention suture* which also passes through the skin, but is introduced at a relatively greater distance from the wound edge than the former, and includes a relatively considerable amount of tissue in its bite, usually virtually the entire thickness of the wound, and the purpose of which is to prevent rupture of the wound as the result of unusual and unforeseen stresses and strains. The latter type of stitch was used much more commonly some years ago than at the present time; surgeons have come recently to realize more and more that the essential features of successful wound closure are (1) careful and accurate anatomical restoration of the cut tissue planes, (2) the avoidance of so-called "dead spaces," and (3) complete hemostasis, and that when these three fundamental principles are disregarded no amount of trussing or splinting by whatever means will prevent the development of untoward results, and that conversely where these principles are observed lighter suture material may be used and less tissue included by the stitch with impunity. Deep sutures were first discarded in the smaller lower abdominal wounds, then in the larger lower abdominal wounds, and many surgeons have finally come to discard them even in the case of the upper abdominal wounds, however extensive. Doubtless the time is not far distant when the "tension" suture will cease to be used entirely unless possibly in the extremely obese patient and in the case of carcinomatosis.

a. The proper time for removal: Since the superficial or coaptation suture is merely a skin suture and serves the single purpose of keeping the incised skin edges in accurate apposition it will have ceased to serve its useful function as soon as healing has advanced sufficiently to prevent the skin incision from gaping when the former temporary support has been removed. Just when this time has arrived becomes a matter of judgment, for the rapidity of healing of any skin incision depends upon many factors amongst which are (1) the age of the patient, (2) the general physical condition of the patient, especially the presence or absence of certain organic diseases, such as diabetes, carcinomatosis, and nephritis, (3) the presence or absence of infection, and (5) the amount of blood supply to the part. Obviously skin wounds in young, healthy individuals and wounds which have undergone no suppuration and are not called upon to allow tissue fluid seepage from the deeper parts will heal more readily than the opposite varieties. Furthermore, wounds of the face and scalp, both of which areas have a relatively rich blood supply, can be depended upon to heal much more quickly than, for instance, an incision made in a leg which is the seat of varicose veins.

Accordingly, it will be appreciated that no rules can be made which will apply either to all individuals or to all parts of the body. It is usually considered advisable not to remove skin sutures from abdominal wounds in less than seven days in the case of the average incision which is aseptic and which apparently is healing normally. Undoubtedly there are many instances, the patient being young and robust, in which removal at the end of five days would do no harm, and on the other hand in many or most cases the stitches in such a wound might be left undisturbed for ten or even fifteen days without doing any particular harm. However, the general seven-day time limit for abdominal skin suture removal does not apply to other regions of the body. In some localities, as about the neck and face, especially of women and girls, a minimum of scar formation is a factor of considerable importance; the same

delay in removing stitches from such an incision as from an abdominal one might become a real calamity because of scar formation; such wounds do not usually tend to gape, the blood supply to the part is usually rich, and the early removal of the suture material is followed by no untoward results; often this may be done at the end of forty-eight hours.

The course of events when non-absorbable, or not easily absorbable sutures are left in the skin too long should be borne in mind in cases of doubt; for a certain length of time, unless the formation of a stitch abscess supervenes, sutures introduced into the skin present an unchanged appearance, the points of entrance and emergence of the suture material present the appearance of small puncture wounds which fit snugly about the suture material, and the suture itself hugs the tissue within its bite snugly, but not tightly. As time goes on, however, the first change that is noted, as the result of too great delay, provided that too much tension has not been exerted in tying the suture and undue edema of the part has not caused the suture to begin to "cut out" previously, is a certain looseness which results from a pressure necrosis of the less cellular subcutaneous tissue which has been included in the bite of the suture; the amount of looseness that can develop will, of course, depend upon the amount of subcutaneous tissue included, i.e., in the depth to which the suture needle was originally made to penetrate. The next change that takes place, in the absence of infection, which is, of course, also likely to ensue in cases where removal of sutures is neglected, is a pressure necrosis or ulceration of the skin itself which transforms the original circular punctures through which the needle was originally passed into slits, elongation of which is progressively toward the incision, or, in other words, toward each other; the process terminates when the suture finally cuts through and comes away. This process of ulceration by "cutting through" is accelerated by too tight tying of sutures or by the development of an undue amount of edema. Sutures which have begun this process, either because

they have been left *in situ* too long or because originally they were improperly inserted or too tightly tied, should be removed as soon as possible, for once this process has originated it

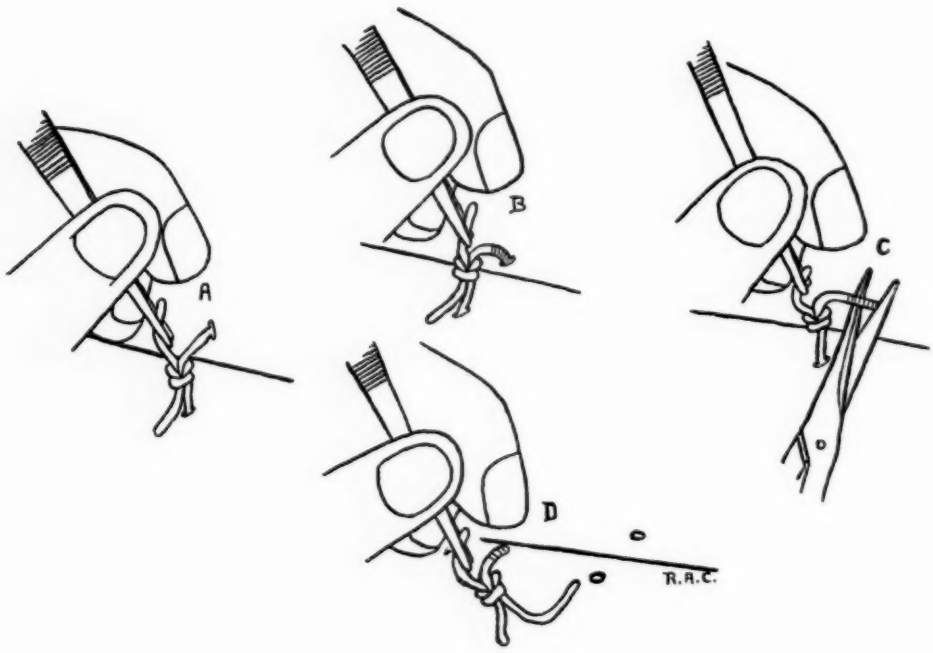

FIG. 51. The four steps in the proper removal of sutures. "A," the suture is grasped with forceps. "B," traction is made with the forceps until a short portion of the suture has been dislodged from below the surface of the skin. "C," the suture is cut in that portion of its length which previously lay below the surface. "D," further traction on the forceps pulls the suture completely away.

tends to progress with some rapidity and it provides an excellent nidus for infection, besides incurring additional scar formation.

b. The technique of removal: Most patients have a real dread of the removal of sutures; this is due partly to an apprehension born of the previous suffering experienced by the patient in connection with the original operative procedure and partly in many instances to the perpetuation of a tradition passed down from the days when untreated silk, linen, and cotton thread were used as suture material; during the process of healing, tissue cells grew into and permeated the interstices

of these threads and, accordingly, the withdrawal of such material was attended by the disruption of considerable newly formed tissue, a process which was quite painful. Impregnation of silk with paraffin or some other preparation, such as celluloid (Pagenstecher), and the use of other impervious suture materials like silkworm gut as practiced at present makes the removal of sutures a relatively painless procedure, providing only that the surgeon be fairly dextrous in the use of his fingers and gentle in his manipulations.

When the surgeon is ready to remove sutures, the field having ever since the operation been protected from contamination by sterile dressings, there should be no need theoretically for any preliminary sterilization of the involved skin area; practically, however, skin sterilization, even with the most painstaking technique is probably never absolute, and even though it were, bacteria, being ubiquitous, have almost inevitably had ample opportunity to work their way under the dressings. Although not then absolutely necessary, it is usually advisable to swab the suture-line with alcohol or with some other antiseptic solution before attempting the removal of sutures. Sometimes peroxide of hydrogen is an ideal substance to use for this purpose, as the solution bubbles violently when coming in contact with the wound area and this bubbling tends to float away dried secretions which may be present, as well as to soften and render pliable certain suture materials.

The technique of suture removal is simple and can be easily understood from a brief consideration of the illustrations (Fig. 51). The suture is siezed with forceps at or near the knot and gentle traction is made until a quarter of an inch or more of the suture material has been pulled up from below the surface of the skin; to aid in this maneuver gentle counter pressure may be exerted on the skin surface near the point of emergency of the suture. The suture being partly dislodged in this manner, the point of a pair of sterile scissors is slipped under the suture and the latter is cut through in that portion

of its length which formerly lay below the surface; this latter is a portion of the suture certainly sterile, providing the wound itself is sterile. Not too much traction should be made during this manipulation, however, lest some of the suture on the other side of the wound be correspondingly pulled under the surface of the skin. It now remains only to continue to pull with the forceps upon the suture, which now having been cut, pulls away from the other direction completely without, however, drawing under the skin surface in that process any part of the suture that was not previously subcutaneous. This almost completely avoids the possibility of contaminating a previously clean suture track.

Tension sutures may be removed on an average two days later than the coaptation sutures.

In the case of old or debilitated persons, or persons suffering from organic diseases and carcinomatosis, sutures should not be removed from the simpler abdominal wounds earlier than the tenth day unless the sutures are beginning to "cut out," and the tenth-day limit may well be made to apply routinely for certain operations other than abdominal incision, such as perineorrhaphy and hernioplasty even in the robust and healthy.

c. Reinforcement of wounds from which sutures have been removed: If there be any doubt, after the removal of sutures, as to the adequacy of the strength of the operative scar, fairly wide strips of adhesive plaster may be placed across the suture-line in such a way as to splint it. Such splinting of a wound which has been the site of a drainage tube may possibly prevent the development of an embarrassing incisional hernia. If such adhesive bridges be placed across infected wounds they should be changed not less often than every second day.

Not infrequently it becomes undesirable to submit the skin of a patient to the maceration and abuse incident to the stripping away of adhesive plaster as often as may be required by the number of dressings indicated, and it accordingly

becomes advisable to devise some means whereby the plaster itself may be left *in situ;* this is easily accomplished. Strips of adhesive plaster are cut to a convenient length, one end being folded over and a piece of ordinary dressmaker's tape attached thereto; the pieces of adhesive plaster are applied at a slight distance from the margins of the wound opposite each other and the pieces of tape are tied across the wound, thus forming a supportive bridge. The dressing may be changed by simply unfastening the flexible tapes and retying them over the new dressing.

III. Classification of Surgical Wounds with Respect to Sterility: Infection

Surgical wounds are subdivided into three classes: (1) clean, (2) contaminated, and (3) infected.

Clean wounds are those which contain no pathogenic microorganisms, and all surgical wounds should belong to this class except those which necessarily invade previously infected tissues. Unfortunately, accidental contamination of clean wounds does occasionally occur, and in any case, the contamination of wounds communicating with infected areas is usually unavoidable.

The contaminated wound may be defined as one which contains on its surface pathogenic organisms, which, however, are present merely as foreign bodies, and which do not instigate any detectable defensive reaction on the part of the tissues with which they are in contact. Naturally, such a condition of affairs represents, in the ordinary case, merely a stage in the development of infection, for pathogenic microorganisms usually find on wound surfaces conditions favorable to their rapid multiplication, and such multiplication soon incites a definite reaction on the part of the host.

Infected wounds are those in which the presence of bacteria has called forth a host-invader reaction on the part of the tissues. The reaction is fundamentally inflammatory. Not only do cellular blood elements invade the tissue spaces in

the region of the bacteria, but phagocytic leukocytes engulf the bacteria and carry them far and wide into the contiguous tissue spaces.

Accordingly, in the case of infected wounds, not only do the tissues show an inflammatory reaction which they did not show in the case of the contaminated wound, but the bacteria which in the former case lay merely on the surface of the wound, now can be found embedded in the adjacent fixed tissues.

Although it is not, of course, possible to determine in any particular case when a wound has ceased to be merely contaminated and has reached the stage of infection except by biopsy, eight hours are usually set as a somewhat arbitrary boundary between the two conditions. This time interval does not, of course, represent the latent period of the clinical symptom and signs of infection, as infection becomes clinically recognizable only after it has become considerably advanced. Pathogenic microorganisms show considerable variation in the rapidity with which they are capable of establishing tissue reactions.

Anaerobic bacteria are apparently taken up by the tissues more rapidly than aerobic bacteria, and excite defense reactions on the part of the tissues earlier; clinical reactions to anaerobic infection characteristically occur within from seven to eleven hours, whereas such reactions from the aerobic bacteria are delayed till the end of from eighteen to forty-eight hours.[4]

IV. The Treatment of Infected Wounds

A. Care of Wounds Infected at the Outset: Obviously the best that can be done for wounds infected at the outset, which have been simply drained at operation, is to prevent further contamination. Such wounds should be dressed and treated according to the principles about to be laid down for secondarily infected wounds. Dressings should be applied to such wounds while they are acutely infected with the same

scrupulous aseptic care and conscience which marks the first dressing in the operating room of a clean abdominal incision.

B. Care of Wounds Developing Postoperative Sepsis: The development of a septic process in connection with incisions into previously non-infected areas should give the surgeon and his assistants well-founded cause for chagrin. Four sources for such infection are obvious:

(1) Inadequate preoperative sterilization of linen, instruments, and ligatures,

(2) Inadequate sterilization of the operative skin area,

(3) Faulty operative technique,

(4) Postoperative contamination of the wound.

Over all these sources of infection the surgeon exercises, or should exercise, control, and therefore upon him, either directly or indirectly, rests the responsibility for all infections developing in clean surgical cases.

Formerly, the faulty preparation of catgut ligatures was frequently blamed for infections in wounds, but the manufacturers of catgut have now become so meticulous in their methods of sterilization that a surgeon would at present lay himself open to just criticism were he to attribute postoperative infection to this source in the absence of direct laboratory evidence to support his assumption; furthermore, were he to find such evidence he would have no excuse for failing to discontinue his use of catgut from the contaminated source immediately in favor of a new supply of reputable manufacture.

As the well-being of the patient is the only excuse for the existence of the hospital, and as the person directly responsible for the surgical patient's well-being while in the hospital is the surgeon, the activities of all those who serve the surgical patient directly or indirectly should obviously be at all times under the surgeon's closest scrutiny and direction. For this reason, that surgeon must be considered remiss in his duties who does not assure himself, from time to time, that the instruments and other material which he uses, under the assumption that they are sterile, are actually sterile in point of fact, and

that the customary routine used in the sterilization of the instruments and other material in the institution in which he works is such as to assure consistent sterility.

By the same token, the use of instruments and other surgical supplies after sterilization, whether by himself or by some other person delegated to attend the patient in the surgeon's absence, should be made a matter of conscience. Persons who show any tendency toward carelessness in their practical interpretation of asepsis should not be allowed to serve in a capacity in which they could become dangerous; student attendants should be most carefully trained to appreciate and revere sterility; and the surgeon himself should be meticulous in his own technique, both as a matter of principle and as a matter of example.

In spite of the measure of vigilance commonly practiced in these matters, it still remains true that the most frequent source of postoperative fevers not obviously explainable on other grounds is the occurrence of wound infection, or at least the forerunner of infection, hematoma and slough formation in the depths of the wound. The possibility of sepsis may be systematically investigated in suspected cases by grasping the whole thickness of the wound between the thumb and forefinger and following, thus, along the entire extent of the incision in an attempt to locate areas of sensitivity or induration. The infectious process invariably lies at the point of greatest tenderness.

Factors predisposing to wound infection are:

(1) Incomplete venous stasis at the time of operation,

(2) The grasping with forceps and subsequent ligature of sizeable masses of tissue which must undergo subsequent liquefaction and absorption,

(3) The inclusion of skin edges in the suture-line,

(4) The excessive use of suture material, whether as to size, number of pieces, or length of loose ends.

Bacteriological culture should be taken as soon as infection of a clean wound is recognized or suspected.

In the presence of wound infection, the primary principle enunciated by the ancient maxim *ubi pus, ibi evacuat* should, of course, be respected, and immediate steps should be taken to lay the infected area widely open by removing not only any sutures actually passing through the involved portion of the wound, but also those in immediate proximity to the involved area.

The principles underlying the subsequent treatment of infected wounds are of great importance and must be considered at some length. Frequently the first tendency of the surgeon, when confronted with frank postoperative wound infection, is to turn to the use of chemical antiseptics. Knowing the comparative ease with which various other articles and substances can be sterilized chemically, it commonly appears reasonable that the disinfection of an infected wound should not present any particular difficulty. Indeed, the antiseptic treatment of infected wounds has in the past found a considerable place in surgery, and the antiseptic solution, in one form or another, has frequently been employed virtually to the exclusion of all other methods in the treatment of sepsis.

1. *The Use of Antiseptics:* a. Phenol and the older antiseptics: The introduction of the carbolic acid spray as a combatant of sepsis by Lister in 1865 signalized the beginning in surgery of the development of the antiseptic method of treating wounds. As far as phenol itself was concerned, however, only about one generation was required to discover the relative unfitness of this substance.

Even before the close of the last century there began to appear in medical literature reports of serious complications following the phenol treatment. Lévai in 1897[5] reported a series of 26 cases in which gangrene had supervened as a result of the repeated application of carbolic acid to wounds; in 12 of these carbolic acid had been used in weak, and in 14 cases in concentrated solution. As a result of certain experiments designed to elucidate the mechanism by which such gangrene was produced, Lévai was able to show that the application of

weak solutions of phenol produces a hyperemia and edema of the treated part which lead to local necrosis and mummification. Harrington,[6] three years later, collected from the literature 132 cases of carbolic acid gangrene and described 18 cases of his own. He believed that the danger of such a complication was greater in the case of weak than of strong solutions.

In succeeding years the toxic systemic manifestations of the absorption of phenol came to be recognized with increasing clarity, and in 1919, Le Clerc[7] described in classical manner not only phenol gangrene, but the generalized symptoms of phenol poisoning, hallucinations, excitement, high fever, and delirium.

Because of these untoward effects of phenol, as well as its damaging action on the kidney during its elimination from the body, no well trained and thoughtful surgeon at the present time would be willing to countenance the continued use of even very dilute solutions of phenol either as a spray wash, or moistening agent in the preparation of wet dressings to be used as more or less permanent applications to infected wounds.

Unfortunately, the fact is not even yet sufficiently appreciated, that carbolic acid is but one of a group of substances classed collectively as phenols all of which show the same, or at least, very similar toxic properties, lysol and cresol, to mention but two representatives of this class of substances.

It may be taken as definitely established that neither phenol nor any of its simpler derivatives should ever be used in any strength whatever as a repeated application to wounds.

Partly as a result of an awakening consciousness of the dangers associated with the use of phenol and partly as a natural expansion of the general principle of antisepsis, a large number of substances possessing antiseptic properties have been developed since the time of Lister as suitable agents for use in infected wounds. Many of these have now been used for so many years that their properties have become "part and parcel" of every medical student's education, and a rehearsal of even the more salient facts known regarding them would not

only consume an undue amount of space but would simply involve a repetition of information easily available in all textbooks on materia medica and pharmacology. Amongst the more important of these agents are alcohol, hydrogen peroxide, iodine, the salts of mercury, potassium permanganate, boric acid, picric acid, the mineral acids, the basic hydrates, and various preparations of silver.

In the years preceding the World War these and similar agents of relatively simple chemical composition were widely used in the treatment of sepsis not only in varying strengths and combinations, but also by different methods, i.e., in the form of ointments and salves, soaks, sprays, and compresses. A recital of the methods used and a comparative study of the results obtained would make interesting historical reading, but such a review is largely irrelevant to the present discussion, because the martial crisis of 1914 speedily and unquestionably demonstrated the essential inadequacy of all methods previously developed for the treatment of infected wounds. This may seem, even after the lapse of a number of years since the termination of that struggle, like an offhand way of dismissing the matter, but not only was the pooled knowledge and experience of the surgeons of all armies, representing the best thought and practice of the medical profession, unanimous on that point at the time, but the subsequent development of events has only served to emphasize the truth of the statement. The revolutionary developments in the treatment of sepsis precipitated by the World War and subsequently expanded have been mainly three:

1. The elaboration of the Carrel-Dakin treatment,

2. The discovery of a number of new, and for the most part chemically complex, antiseptic substances,

3. The expansion of an essentially different mode or principle of treatment, not involving attempts at chemical sterilization, which will be discussed presently, and which may be provisionally called "biological antisepsis."

Leaving aside, for the moment, the Carrel-Dakin treatment and "biological antisepsis" to continue with the discussion of antiseptic substances as such, a word must be said concerning the more recent tissue antiseptics. As a result of the general recognition of the inefficiency of the older germicides in tissue antisepsis many new drugs have been developed and exploited during the past decade or more.

b. Hypochlorous acid, Chloramine T, and Dichloramine T: On the one hand, the generally satisfactory results obtained during the war with sodium hypochlorite by the Carrel-Dakin technique served to stimulate investigation of various other chlorine containing compounds in the hope that a more satisfactory chlorine derivative might be found, and on the other hand, various attempts have been made to evolve antiseptics not chemically allied to sodium hypochlorite but possessing its supposedly beneficial characteristics, high toxicity for bacteria and low toxicity for tissue cells.

In addition to Dakin's solution, the tissue antiseptics of the chlorine group which have been found of especial value are (1) hypochlorous acid and its salts, and (2) the closely related compounds, chloramine T (sodium toluene sulphonechloramide) and dichloramine T (toluene sulphonedichloramide).

The preparation of hypochlorous acid which has found the greatest favor is known as "eusol"; it was developed originally by Lorrain Smith and is prepared as follows:

> Twelve and a half grams of chlorinated lime are placed in a flask of resistance glass, and to this is added a liter of distilled water. The flask is thoroughly shaken. Twelve and a half grams of boric acid are added, the flask is again thoroughly shaken and subsequently allowed to stand for several hours at room temperature. The contents of the flask are now filtered through cotton wool. The clear liquid thus obtained is the finished product.

Chloramine T is a water-soluble, crystalline drug, and is used most frequently either directly in 2 per cent solution, or in the form of impregnated gauze; this is prepared by immers-

ing the plain, dry gauze in a 5 per cent watery solution of the drug, the gauze being subsequently dried.

Dichloramine T is also a crystalline substance but is almost completely insoluble in water, though rather freely soluble in certain oils. The oils most commonly used are chlorinated eucalyptol and chlorinated paraffin wax; solutions of from 6.5 per cent to 10 per cent are satisfactory. Solutions of dichloramine T are stored in brown glass bottles and are carefully protected against contact with water; solutions which show precipitates (crystalline toluene sulphonamide) are unsuitable for use and should be discarded.

None of these chlorine containing compounds has succeeded in establishing itself in medical favor to the same extent as Dakin's solution, though they are much more stable and consequently, from that point of view, more desirable.

c. The newer antiseptics, Mercurochrome and Hexylresorcinol: The other inter-war and post-war antiseptics which have become popular are partly products of the aniline dye industry, and partly substitution products of other compounds used extensively in industrial chemistry. They represent substances of much more complex chemical composition than the antiseptic standbys of the pre-war period. Amongst these antiseptic agents certain ones have found particular favor on the Continent, and certain others have been used more particularly in the United States.

The Continental group includes brilliant green, malachite green, flavine, acriflavine, trypaflavine, and rivanol. The American group includes, along with a number of less well established drugs, mercurochrome and hexylresorcinol.

The relative merits of these antiseptic substances have by no means been settled and their supposed advantages over substances of simpler composition, more modest price, and longer lineage are still open to very serious question. In this country, of course, a discussion of these newer antiseptics centers chiefly about mercurochrome and hexylresorcinol.

Mercurochrome: Mercurochrome was introduced into medicine and popularized largely through the influence of Hugh Young.[8] Originally used more particularly as an antiseptic in genitourinary practice, this interesting, brilliant red substance has been employed not only on mucous membranes of other parts of the body, but has been introduced directly into the blood stream in the treatment of septicemia, and has been used more or less widely as a general skin disinfectant; it has been employed both in simple watery solution and suitably reinforced with acetone and alcohol. Opinions as to its value in the treatment of sepsis differ considerably; Sanner and Hill[9] have recently presented experimental evidence to show that it is of value in the treatment of local infections; Wright[10] finds it effective in the destruction of the Staphylococcus aureus but of no value in the destruction of Bacillus pyocyaneus; and Rodriguez[11] believes that it is quite inefficient when in 2 per cent aqueous solution, and unsatisfactory even in 5 per cent solution in alcohol and acetone.

Hexylresorcinol: Hexylresorcinol is an alkyl resorcinol, and accordingly a derivative of phenol; the biological properties of the class of substances to which it belongs were originally outlined by Veader Leonard,[12,13] and this particular member of the series has been popularized by Leonard and his associates. Leonard and Feirer[14] recommend for general antiseptic purposes a solution containing 30 per cent glycerine and 70 per cent water in which is dissolved 1 mg. of crystalline hexylresorcinol per cubic centimeter; such a solution possesses a surface tension of 37 dynes per centimeter and is therefore known as "S.T. 37." These authors find[15] that in the guinea pig, wounds artificially inoculated with Staphylococcus aureus, Streptococcus viridans, Streptococcus hemolyticus, and Bacillus coli are invariably sterilized by "S.T. 37" within one minute. Allen and Wright[16] however, have investigated the bactericidal properties of "S.T. 37" and draw quite different conclusions. They find that it is not effectively bactericidal for Bacillus pyocyaneus in forty-eight hours, but that it is bactericidal for Staphylococ-

cus aureus in something less than ninety minutes, and destroys Streptococcus hemolyticus in fifteen minutes or less.

The foregoing discussion of antiseptics is offered merely as a sketchy and abbreviated account to serve as an introduction to a consideration of the general place of antiseptics in the treatment of infected wounds.

d. General evaluation of the method of antisepsis: The very number and variety of the antiseptic substances previously considered should offer convincing evidence of the general unsatisfactoriness of antisepsis as a method. The ideal antiseptic has eluded the search of the medical profession like the proverbial "will-o-the-wisp," and by and large, each new substance, though hailed with high hopes at the outset has been finally forced, or is by way of being forced, into virtually the same measure of disfavor as its predecessors. That the shortcomings of these substances are not due to their inability to destroy micro-örganisms as such is very obvious, for with but few exception, all of them show very marked and satisfactory germicidal powers outside the body. The satisfactory sterilization of unbroken skin is rather readily accomplished by some of them. When the skin is broken, on the other hand, and the tissues become infected, a situation is created which is intrinsically different.

Were the bacteria in an infected wound confined to the cavity of the wound or even the superficial layer of tissue lining the sides thereof, the application of a suitable antiseptic to the wound cavity might well succeed, in certain cases at least, in destroying all the bacteria present and in thus sterilizing the wound completely. This is, of course, one's object in pouring strong antiseptics into freshly made contaminated wounds which for one reason or another cannot be thoroughly debrided, and such treatment, though not always effectual, is at least not irrational.

In infected wounds not less than three considerations combine to annul any good effects which bactericidal drugs might otherwise have.

(1) In such wounds the bacteria have already invaded the fixed tissues adjacent to the wound edges, having been phagocytized by the actively motile leucocytic cells, and in many cases have been transported far and wide into the regional tissue spaces and lymphatics; during this process many of the microorganisms, not overcome by the body defensive mechanisms, have undergone extensive multiplication. The application of an antiseptic to such a wound cannot be effective because no known antiseptic possesses the property of penetrating tissues to anything like the extent represented by the dissemination of the microorganisms. As a matter of fact, almost all of the common antiseptics have very little penetrating powers at all.

(2) In the case of infected wounds bactericides are required to act not in a watery medium, in which they are characteristically most potent, but in a complex medium, serous, frankly purulent, or even bloody, in which their potency is invariably much diminished. In the case of some of the antiseptics the mechanisms by which their efficiency is diminished in such media is obvious. Many of them depend for their bactericidal action upon their ability to coagulate protein, and when brought into contact with albuminous material immediately defeat their own purposes by building up an impervious restraining wall of coagulum against their own further activity.

In the case of certain stains, particularly the members of the aniline dye group, their bactericidal powers are apparently indissolubly connected with their ability to stain protoplasm, and as Fleming[17] has observed, in a watery solution of bacteria, the bacteria contain all the protoplasm present, so that a maximum staining effect is obtained in such a case, whereas in wounds, leucocytes and fixed tissue cells dissipate the action of the antiseptic by themselves absorbing a considerable part of the stain, thus leaving a much attenuated medium to act upon the bacteria.

(3) Not only do bacteria suffer from the effects of antiseptics when these substances are introduced into wounds, but the

fixed tissue cells and the leucocytes are also destroyed to a greater or lesser extent. In spite of the many attempts which have been made to develop or discover an antiseptic with differential toxicity for bacteria, no convincing evidence has been presented to show that such an end has even been accomplished, or, indeed, that it can be accomplished. Moreover, as the healing process depends ultimately upon the activity of the body tissues, the application of antiseptics to wounds interferes directly with the healing process and so tends to defeat its own aims.

Accordingly, the wise surgeon has now learned to look with suspicion on the entire host of antiseptics when he is confronted with the treatment of an infected wound, because he has discovered that when he is fighting infection he is fighting living organisms which are cells not dissimilar to those of which the body of the host is composed and which are vulnerable even to a less extent in many cases than the body cells themselves, particularly the leucocytes of the blood which are the surgeon's most powerful allies. Only the unwary then are deluded by bright colors, new names, exorbitant prices, and splurges of printers' ink into thinking that every newcomer to the field of antiseptics has finally solved the problem of killing the one without at the same time maiming the other.

2. *The Carrel-Dakin Technique:* The Carrel-Dakin treatment of infected wounds must be considered separately from the general discussion of antiseptics.

In the first place, this form of treatment deserves the utmost respect, because of its proved efficiency in the treatment of the alarming sepsis of war-time surgery, and, therefore, even if regarded as a method primarily involving the principle of antiseptics, should, nevertheless, be considered as preeminently superior to all other methods involving the same principle, and for this reason, entitled to especial consideration.

In the second place, however, the antiseptic used in this form of treatment is inefficient except when used according to a certain definite technique and, therefore, constitutes a notable exception to other antiseptics as a class; the question consequently arises as to whether the antiseptic as such or the method of application is fundamentally responsible for the value of the method.

In the third place, the Carrel-Dakin technique exerts on infected wounds a cleansing action not seen when other antiseptics are used; the particular antiseptic solution shows a marked proteolytic action in accordance with which sloughing tissues are removed and the wound surface is kept mechanically clean; the importance of proteolysis as an adjunct to the treatment of sepsis comes therefore in question.

The Carrel-Dakin treatment of infected wounds is a treatment in which a 0.45 to 0.5 per cent solution of sodium hypochlorite, devised by Dakin, is applied to the surfaces of infected wounds by means of a mechanical distributing system developed by Carrel. The combined technique was painstakingly elaborated especially for the exigencies of military service and was of inestimable value in the treatment of war wounds. This form of treatment has been found particularly applicable to the severest types of infections, both military and civil, especially to those which are amenable to no other form of therapy, but it can be used to equally good, or even better, advantage in those infected wounds often regarded as of minor significance and commonly treated by other means. Against the Carrel-Dakin therapy there is still little to be said except from the point of view of expediency. Time has sufficiently demonstrated that only those individuals fail in the use of the method who modify it, i.e., who substitute here or there modifications of their own for the details of the established technique. The matter of expediency, however, is not to be lightly dismissed as the technique is rather exacting, and, in order to follow it adequately it is necessary (1) to have access to a supply of freshly and accurately prepared solution,

(2) to have a means of obtaining frequent and accurate bacterial examinations, (3) and to be able to command full cooperation both day and night of an especially trained nursing staff, facilities which are, it may be said only rarely available in the average civil surgical practice.

Dakin's solution is prepared and standardized chemically once every twenty-four hours in such a way that its percentage strength is within the limits indicated previously; if used stronger than this it becomes irritating and destructive, if used weaker, it is of little or no value as a sterilizing agent. Solutions rapidly lose their titer on standing and become ineffectual. It is for this reason that insistence is placed on accuracy and freshness of preparation.

Upon the bacterial count of smears from wounds depends one's ability to gauge the measure of success of the treatment, to handle the mechanical adjustment of apparatus with intelligence, and to determine the opportune time for subsequent wound closure. Without this the method of necessity becomes a haphazard affair.

As mechanical maneuvers subsequently to be described must be performed at frequent intervals and without intermission, and as the surgeon himself cannot be constantly at the side of the patient, dependability, intelligence, and experience with the method on the part of the nursing attendant are an added necessity.

a. The Carrel distributing apparatus: The Carrel distributing apparatuus consists of three fundamental parts:

(1) The reservoir for containing a supply of the irrigating fluid,

(2) A rubber connecting tube which is provided with a pinchcock and which serves to conduct and regulate the flow of fluid from the reservoir to the next or third part of the apparatus,

(3) A branching system of tubes partly of glass and partly of rubber which serves to bring the fluid into direct and intimate contact with the wound surface to be sterilized.

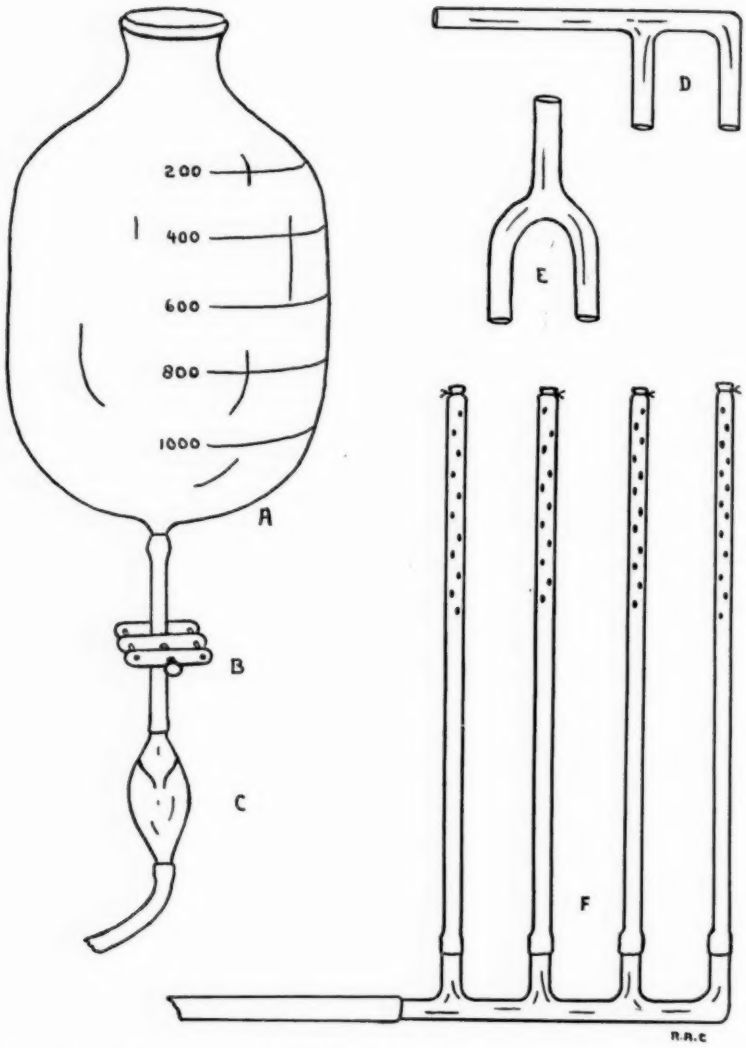

FIG. 52. Essential features of Carrel technique for use of Dakin's solution. "A" represents a bottle or container which acts as a reservoir; this container is best made of amber colored glass in order to minimize disintegration of contained solution by actinic light rays. "B" is a screw-clamp which is best not allowed to remain open continuously, as in the "drip" methods, but remains closed most of the time and is opened more or less widely for a few moments only at intervals for the production of "tidal irrigations." "C" is a dropping tube which functions as a means of visualizing the approximate amount of solution released when "B" is opened. "D" and "E" are two different types of glass delivery tubes. "F" is a four-armed delivery tube which has been fitted with rubber distributing tubes; these rubber tubes are perforated along the sides with many small holes and at the ends are tied tightly with pieces of cord; this part of the apparatus is ready for insertion into an infected wound.

The reservoir is of glass, usually amber colored to minimize disintegration of the contained solution by actinic light rays, and is conveniently of a capacity of 500 to 1000 c.c.; it is suspended at a height of 2 to 3 ft. above the wound to be irrigated, being attached to any convenient support, an adjustable irrigating stand being often desirable, but by no means necessary for the purpose.

The rubber connecting tube is of a length of a couple of yards and has a lumen about 7 mm. in diameter; it is always provided with a pinchcock to regulate the rate of delivery of solution and it may or may not contain interpolated in its length below the pinchcock a glass dropping tube.

At the end of the rubber connecting tube is a glass tube which may be simple and straight, or which may contain from one to many side tubes depending upon the size of the wound to be irrigated and the number of terminals necessary for the purpose. Each one of the glass side tubes is provided with a length of rubber tubing which forms the most terminal part of the irrigating system, i.e., which establishes contact with the tissues. These latter rubber tubes are of varying lengths depending upon the size and shape of the wound in connection with which they are to be used; they have a lumen of about 4 mm. in diameter and are relatively thin walled; they are usually tied tightly at the end and perforated along the sides. The perforated part of these tubes may or may not be covered with turkish towelling stitched in place to distribute the fluid more evenly to the surfaces of the wound, but this covering of the tubes is not advised in the latest descriptions of the technique as given by its promulgators (Fig. 52).

b. Preliminary preparation of the wound for Dakinization: Preliminary preparation of the wound consists primarily in securing free access to any angulations and pockets that may be present in the wound and the surgical removal of debris in order that the antiseptic fluid to be subsequently used may have free access to all parts of the infected area, and may come into more or less direct contact with viable tissue. The area

around the infected wound being prepared as for any other surgical operation and having been painted with benzine followed by iodine, devitalized tissue is freely trimmed away, necrotic tissue is removed, and foreign bodies if present are dislodged and evacuated; added incisions may also be necessary in order to provide access to partly closed pockets. If at all possible, in doing this the fingers should never be used directly in the wound, but the various manipulations should be performed solely by the intermediation of instruments. Cultures should be taken at this time, if such has not already been done, these to be examined subsequently for purposes of identifying the organisms present and for estimating the approximate number of such organisms.

c. The placing of the distributing tubes of the irrigating apparatus: The wound is now ready for the placing of tubes; some planning is usually necessary in this part of the prodecure to ensure that the liquid may come into intimate contact with every remotest corner and diverticulum involved in the infective process. No specific directions can, of course, be given as to how this can be done most effectively; every case is a problem in itself because no two wounds are ever of identically the same shape and size. If the operator has fair mechanical sense, however, and if it be remembered that the problem is purely one of hydrostatics, the course of liquid under pressure, it should in the average case be a matter of no especial difficulty to insure free circulation throughout the entire infected area. This is the essential feature of the treatment, and unless such a result be obtained the best end-results can scarcely be expected.

The tubes having been arranged, attention is directed to the dressing of the wound. This is effected by means of gauze compresses dipped in Dakin's solution and placed in position with dressing forceps, the fingers in this case, as before, not coming into contact with the wound surface if at all possible. The healthy margins of the skin should be protected from the direct action of the solution by vaseline, for Dakin's solution

is irritating to the skin. Much can be done while placing the compresses to assure an equal distribution of the solution by building up one part of the dressing to act as a dam against excessive overflow and loose packing of another area to assure the attraction of fluid to such a part by capillarity.

The finished dressing should be fairly voluminous and should be built up about the tubes; it should be held in place by bandages in locations where these can be used to advantage; otherwise, strips of adhesive plaster are used. The tubes may be pinned to the finished dressing in order that such movements as the patient makes may not dislodge them.

d. Subsequent care of the apparatus: *Irrigation:* Formerly it was the custom to employ a continuous irrigation technique, the rate of flow being adjusted so that in the average case 5 to 20 drops of the solution were delivered to the distributing system every minute. At present it is considered better to open the pinchcock from the supply reservoir only at intervals of about two hours allowing enough fluid to escape into the distributing system each time this is done to resaturate the dressings. In the average case the amount will vary between 10 and 15 c.c. and the time consumed in this process, from one to three seconds. This must be done with religious regularity day and night. It is essential, furthermore, to see that the permeability of the tubes is assured at all times.

R*edressing:* Once during the course of each twenty-four hours the wound is uncovered, inspected, and redressed with fresh gauze compresses. The time for doing this should be so chosen that two hours will have elapsed since the last irrigation, because during the course of the dressing bacterial smears are always taken for subsequent examination, and it is desirable that these be taken at as unfavorable time as possible in order that the attendant be not misled as to the effectiveness of the treatment, which in turn might lead to its too early discontinuance. No hesitation should be felt in readjusting tubes or rearranging the distribution of compresses during the course of any dressing in order to correct faulty distribution of the

fluid, providing the fingers be not placed in the wound and an otherwise rigidly aseptic technique be observed.

e. Bacterial smears: Bacterial smears not only give information as to the kind of organisms present in the wound, but also as to the progress of the infection, or, in other words, the effectiveness of the treatment. If the number of organisms found on examining a smear be greater than on previous occasions, obviously the battle is with the invaders, and unusual care should be used at the next dressing to search for the cause and, if possible, to remedy the condition. If, however, daily counts show a steadily decreasing number of organisms the treatment is obviously succeeding, and there is no particular indication for greater care than previously used or change of regime. When on 3 successive examinations at intervals of twenty-four hours, only 1 coccus or a pair of diplococci are found to 4 or 5 high-power fields of the microscope the wound is considered sterile and may be sutured in the same manner as any surgically sterile wound.

In some of the base hospitals toward the close of the World War it was customary to require 3 successive negative smears, the last being controlled by culture, before secondary suture was permitted.

Badly infected wounds required about seventeen days for sterilization by the Carrel-Dakin method.

A consideration of the several factors concerned in the proper performance of the Carrel-Dakin technique, none of which may be slighted if the method is to succeed, very strongly suggests that the principles of antisepsis play but a minor rôle in this particular form of treatment. The fact that too strong solutions of sodium hypochlorite act as irritants and interfere with healing is not without significance, for all other antiseptics can be used more or less indifferently in various strengths, and if Dakin's solution depended for its action on its antiseptic powers slight variations in percentage composition should not make so marked a difference in results. Similarly, in considering too weak solutions of hypochlorite of soda, some antiseptic

effect should be expected, provided this were the principle primarily responsible for the value of the method, even though the strength of the solution were not exactly maintained; such, however, is not the case, and wounds treated with solutions even slightly below titer rapidly become foul and covered with sloughs.

Although not yet definitely proved, it seems very likely that a large part, if not all, of the effectiveness of the Carrel-Dakin technique depends upon certain principles immediately to be discussed in connection with "biological antisepsis," and if so, the action of Dakin's solution is not primarily disinfectant.

3. *Biological Antisepsis:* Biological antisepsis presupposes the impossibility of sterilizing a wound by the use of chemical antiseptics and depends entirely upon aiding the physiological or biological agencies which make for natural recovery. As will readily be appreciated, such a program is ambitious, to say the least, and when one stops to consider that only since the World War has this conception gained any degree of favor, one need not be surprised to find that the principles of treatment which have thus far crystallized are relatively embryonic.

Biological antisepsis, however, both theoretically and practically presents such obvious advantages over other methods of treating sepsis that one is probably well within the bounds of truth in stating that not only has greater progress been made in the treatment of infected wounds during the past fifteen years than in all the centuries preceding, but also that all future progress must be based upon biological or physiological methods. To Sir Almroth Wright and his followers we are largely indebted for the progress thus far made.

a. The importance of free drainage and macroscopical cleanliness in the treatment of infected wounds: Although the importance of free drainage in connection with infected wounds has been taught to some extent for centuries and the value of primary surgical removal of devitalized tissue, foreign bodies, and disintegrating blood-clot, has been more recently estab-

lished, particularly as a result of war-time experience, the rationale of these therapeutic measures is probably not generally appreciated by surgeons. Sir Almroth Wright and his followers have contributed a concept of importance in helping to understand the value of such procedures which, if more generally known, would probably go a long way toward impressing upon the mind of the surgeon the great importance of macroscopical cleanliness as a primary prerequisite in the treatment of all superficial infections.

Normal human plasma, serum, and lymph possess very marked bacteriostatic powers. About the only organisms which will grow in such fluids when inoculated in reasonable numbers, are the streptococci and to a limited extent the staphylococci, and certain diphtheroid organisms. In individuals suffering from severe septic infections the bacteriostatic power of the body fluids is greatly enhanced, and even the organisms mentioned here when coming in contact with such fluids under ordinary cultural conditions grow very sparsely or not at all. Apparently a large part of this bacteriostatic power is due to the presence in the body fluids of antitryptic substances, for when trypsin is added to such fluids they lose their bacteriostatic powers, and this in direct proportion to the amount of trypsin added.

In septic wounds tryptic ferments arise from the disintegration of tissue cells, especially from the disintegration of leucocytes. When such disintegration of tissue cells is maximal, as in the presence of gross sloughs, the antitryptic power of tissue fluids poured into such wounds is minimized or annulled, the antitryptic bodies being neutralized by the tryptic bodies of tissue disintegration.

The presence in an infected wound of gross masses of disintegrating tissue or fluids containing numbers of dead and dying leucocytes is thus seen to offer a most effective hindrance to wound sterilization. Accordingly, the first surgical duty which the medical attendant is called upon to perform when confronted with an infected wound is the establishment of a

condition of gross or macroscopical cleanliness. Not only must the wound be laid wide open, all pockets and diverticula being freely explored, but devitalized tissue must be gently and carefully removed with knife or scissors, so that the wound presents neither pools of purulent material nor sloughs.

b. The use of hypertonic salt solutions: Although the mechanical removal of sloughs and grossly contaminated material from septic wounds enormously conserves the antitryptic powers of the tissue fluids poured into the infected area and thus tends to favor the rapid control of the local multiplication of bacteria, no merely mechanical method can, of course, completely remove all decomposing material from the average infected wound, nor can it prevent continued decomposition of tissues as the result of the further action of bacteria necessarily left behind. The good effect of primary mechanical cleansing of infected wounds does not endure, therefore, unless some added mechanism can be provided to maintain the condition of cleanliness originally instituted. The physiological process by which the mechanical cleanliness of infected wounds tends to be maintained is one of tryptic digestion; the cells undergoing disintegration in the infected area themselves liberate a tryptic ferment which under favorable circumstances is capable of liquefying necrotic tissue and which in this manner favors continuous wound cleansing provided only that the position and other circumstances of the infected area are such as to facilitate drainage of the resultant liquefied material.

As will be appreciated from these considerations, the action of natural tryptic ferments in infected wounds is partly beneficent and partly malevolent, beneficent insofar as the removal of cellular debris is concerned, malevolent insofar as the neutralization of the antitryptic powers of the various tissue fluids is involved.

Any attempt to manipulate the process of tryptic digestion in infected wounds therapeutically must therefore resolve itself into a compromise; sufficient tryptic digestion must be allowed to occur so that cellular debris is adequately liquefied

and eliminated, and, on the other hand, the local concentration of tryptic ferments must not be allowed to become so great as to overcome the natural antitryptic power of the tissue fluids and thus facilitate further suppuration. Very possibly there may subsequently be discovered some more satisfactory method of achieving this end than is at present known, but for the time being, the expedient which seems to be of most value involves the principle of alternation; conditions are alternately produced which favor now tryptic digestion and now antitryptic action.

In order to understand the method usually employed in establishing this alternation, it is necessary to understand that of all the cells liberating tryptic ferments into infected wounds the leucocytes are the most important. Any substance or agency which destroys leucocytes will liberate relatively large amounts of tryptic ferments. The destruction of leucocytes is apparently the primary function subserved by Dakin's solution in the Carrel-Dakin technique. It will be remembered in this connection that according to the later experience with the Carrel-Dakin technique continuous irrigation of wounds was not nearly so satisfactory as intermittent irrigation, and this coincides very well with the theoretical considerations involved in the principle of alternating tryptic and antitryptic action now under discussion.

Certain hypertonic salt solutions are also capable of destroying leucocytes, such as relatively concentrated solutions of sodium chloride and magnesium sulphate. These solutions when applied to infected wounds immediately cause the disintegration of leucocytes and the consequent liberation of tryptic ferments. The salts have no antitryptic powers themselves, so that the liberated trypsin is at once free to act on any cellular debris that may be present. The action of hypertonic salt solutions as thus used is not ordinarily continuous because such solutions very speedily become diluted with wound secretions and when thus sufficiently diluted are no longer capable of causing further disintegration

of leucocytic cells. In the repeated application of moderate quantities of hypertonic salt solutions to infected wounds is thus seen a very efficient method alternating conditions favorable now for tryptic digestion and now for antitryptic action.

Hypertonic salt solutions are of value in the treatment of sepsis, however, not only because of their moderate destructive action on leucocytes, but because of a possibly more fundamental action which depends upon osmotic tension.

The septic process which takes place in the cavity of an infected wound constitutes but part of the total phenomenon of suppuration; in the depths of the tissue contiguous to any infected wound is concomitantly occurring a process of leucocytic disintegration; here degenerating cells are liberating trypsin directly into the tissue spaces thus corrupting the contained lymph, upon the antitryptic and antibacterial powers of which control of infection in the tissue itself depends. Hypertonic salt solutions are capable of withdrawing such contaminated lymph from the environs of the wound and of thus producing a process amounting to an internal lavage of the contiguous tissue. The value of the removal of this contaminated lymph from the tissue spaces and its subsequent replacement by fluid of full antitryptic and antibacterial potency derived from the blood stream can hardly be overestimated.

With regard to the question of the best hypertonic salt solution to use for the purpose described there is no very definite concensus of opinion at present. Wright has recommended a solution consisting of sodium citrate 11 grains and sodium chloride 20 grains to the ounce of distilled water, but there is no evidence as yet available to prove that a combination of salts acts more efficiently than a single one. Ordinary salt, or sodium chloride, is efficient in 5 to 10 per cent solution and presents the obvious advantage over many other substances that it is very cheap and readily obtainable. About the only objection to sodium chloride arises from its irritating properties.

Hypertonic sodium chloride solution is, of course, nothing more or less than "brine," and the discomfort produced by the entrance of brine into an open wound is a matter of everyday experience; however, the solutions of salt customarily used are not strong, and the irritating properties of the solution are accordingly minimal.

Solutions of magnesium sulphate also of 5 to 10 per cent strength present the advantages of economy and availability possessed by sodium chloride and in addition, instead of being, like ordinary salt solution, irritating to exposed nerve ends are actually analgesic. For this reason hypertonic solutions of magnesium sulphate are more grateful particularly to the apprehensive and hypersensitive patient.

Von Gaza[18] contends that the hypertonicity of salt solutions when used in the treatment of infected wounds is not the only factor to be considered, for he has found that though sodium chloride increases the size of granulations in healing wounds the opposite effect is produced by calcium chloride solutions. He therefore concludes that some of the effect produced by these solutions is dependent upon ionization of the wound, and in accordance with his experimental findings he advocates the use of sodium salts in those wounds in which considerable tissue defects require to be filled, whereas in cases in which epitheliazation alone is desired calcium salts are indicated; the evidence presented is, however, not entirely convincing. Until more detailed knowledge of the action of various ions has been developed the question of the particular salt to be used may well be left open, and until further evidence becomes available sodium chloride and magnesium sulphate may be regarded as presenting the necessary characteristics.

c. The agency of absorptive dressings: Up to the present no mention has been made of the bactericidal properties of the leucocytes as such. The leucocytes, as is well known, and as recently emphasized by Wright[19] possess the power not only of excreting, under appropriate stimulation, bactericidal substances designed to destroy bacteria directly, but also the

power of engulfing bacteria and destroying them by a process of intracellular digestion. The action of the leucocytes is thus partly dependent upon their chemical properties and partly upon their power of ameboid movement. Wright believes that the polymorphonuclear cells are able to make their way faster through the walls of capillary blood vessels than the mononuclear cells because of the peculiar irregular shape of their nuclei; by a twisting and turning motion the polymorphonuclear cell wriggles its way through an opening which would more easily restrain a cell with a regularly rounded nucleus. At all events the polymorphonuclear cell finds its way to any seat of bacterial multiplication in the body with remarkable rapidity, and microscopical examination of any grossly infected area invariably shows masses of these cells engaged in active combat with invading microorganisms.

Two essential conditions seem to be necessary in order that the bactericidal activity of the leucocyte may be exerted maximally: (1) the supply of leucocytes must be continually augmented, and (2) each leucocyte must have some definite point of attachment.

If the pus from a closed lesion, such as a furuncle, be examined microscopically it will be seen to contain leucocytes which show little motility or none at all, and if the bactericidal properties of these leucocytes be tested culturally they will be found to be very feeble indeed. The situation is comparable to that of a human battlefield in which no provision has been made to supply reinforcements; the leucocytes typify the defending force which by dint of long fighting has been partly killed, partly maimed and partly disabled by exhaustion. If, on the other hand, an actively healing acute ulcer be examined microscopically, the leucocytes will be found to be actively motile and exceedingly bactericidal in culture. In this case, to use the same simile as before, the dead and wounded soldiers have been removed as fast as they have fallen and new recruits have been inducted into their places. Dressings, because of their absorptive characteristics, play a very impor-

tant part in the removal of such pus as is characterized by the presence of dead and therefore useless leucocytes; in removing this pus an opportunity is afforded for more leucocytes to be mobilized. The actual mobilization of these leucocytes is, of course, facilitated by the action of hypertonic solutions.

The removal of secretions from wounds by the agency of suitable dressings is of value also in providing points of attachment for the leucocytes and thus aiding them in their phagocytic activities. An emulsion of leucocytes swimming free presents relatively feeble bactericidal powers compared with the bactericidal powers possessed by the same number of leucocytes attached to a surface. The situation is as if the invading bacteria and the defending leucocytes were engaged in a tug-of-war and the sides of the wound and the meshes of wound dressings were capable of acting as a fixed support to which the leucocytes could attach themselves to gain an advantage.

d. The action of heat: The action of heat in hastening chemical reactions is almost axiomatic, and inasmuch as a considerable part of the control of any infectious process depends in the last analysis upon chemical reactions, the favorable influence of heat on infectious processes should be considereable.

Ebeling[20] some years ago showed this effect very interestingly when working with alligators. He found that an increase of 10°C. in the temperature of a wounded area actually doubled its rate of healing.

In addition, however, to the influence of increases in temperature on chemical activity, the physiological action of heat in the production of arterial hyperemia and local dilatation of arterioles and venules must not be forgotten. In order for the concentration of leucocytes in a given infected area to be maximal a very rich arterial blood supply to the part must be provided.

e. The action of rest: The value of rest both local and general in the treatment of any inflammatory process is universally accepted and the importance of this factor need not be particularly dwelt upon. Generalized rest is, of course, provided in connection with infected wounds in the confinement of patients to their beds, and localized rest may be enforced occasionally by splinting.

f. The actual treatment of infected wounds according to the principles of biological antisepsis: Assuming that in any actual case of sepsis the age-old principle of the establishment of drainage has been amply respected and that in suitable cases the macroscopic cleansing and "freshening" of wound edges have been accomplished, the practical application of previously considered theoretical principles of biological antisepsis immediately comes in question.

Rest: The condition of surgical patients quite apart from the presence of any localized suppurative process characteristically serves as an indication for the enforcement of generalized rest of the body in bed. However, in the exceptional case in which sepsis develops in ambulatory cases the patient should be promptly ordered to bed so as to favor conservation of any reserve energy of the body for purposes of combating the infectious process.

Local rest of the infected part of the body may or may not be adequately secured concomitantly with the establishment of recumbency in bed. In the case of infected abdominal and thoracic incisions this will, of course, usually be the case. In the case of infections of the neck, head, and extremities some further immobilization is not infrequently necessary or desirable. Local immobilization may be adequately arranged in most of these latter cases by the use of sandbags or pillows so arranged about the affected part as to prevent lateral motion. In rare cases the actual application of an immobilizing splint may be not only feasible but desirable.

The use of hypertonic solutions: As has been previously mentioned, other characteristics beside hypertonicity may be

partly responsible for the good effects produced by the use of hypertonic solutions in the treatment of infections, but in the absence of further and more convincing evidence than is at hand, one is hardly in a position to dogmatize on this matter with too much assurance. It may be provisionally assumed that of two solutions of the same hypertonicity, that one is preferable for use in the treatment of infections which presents the more desirable additional, accidental, or concomitant properties. No one should be misled, however, when using hypertonic solutions for the purpose under discussion into thinking that an additional bactericidal property is to be desired in connection with the solution; such a fallacy has evidently been in the minds of certain authorities who particularly advocate the use of boric acid. Boric acid has sometimes been regarded as a mild antiseptic, it is true, but such bactericidal properties as it may possess are very feeble indeed, even in a watery medium, and must be quite negligible in an infected wound. Aside from this, however, and more fundamentally, no one should be deceived into thinking that in the use of boric acid, or any other substance supposed to possess bactericidal properties in addition to its properties of hypertonicity, one is guided by rational considerations, for if the principle of antisepsis is irrational when considered on its own merits it is no less irrational when combined with any other principle, whether the latter be itself sound or not. Bactericidal properties as such are not desirable in connection with hypertonic solutions used for the treatment of infected wounds.

Incidentally, boric acid has one essential property which is almost certainly not desirable, it is only sparingly soluble. The solubility is from 4 to 5 per cent, and thus a saturated solution is either just at or even somewhat below the lowest value usually regarded as efficient for solutions to be used on infected wounds. Solutions of from 5 to 10 per cent are usually recommended.

In passing, and while on the subject of boric acid, it may be worth while to note that there has been some experimental evidence tending to show that a localized acidosis may accompany the process of repair in infected wounds. If the healing process can be definitely shown to be characterized by regional acidosis, rational therapy in the future may take this factor into account and boric acid, or some other weak acid, because of its acidity, may be generally recognized to have an advantage greater than at present supposed.

For the time being, however, attempts to elaborate practical methods based upon a more or less speculative regional acidosis should not be accepted too enthusiastically, much less attempts to establish generalized acidosis by manipulation of the diet.

Furthermore, there is a little evidence to show that alkalinity may occasionally be more desirable than acidity. Sir Almroth Wright[21] has shown that Welch's bacilli at least grow only with great difficulty in unaltered blood serum; such serum has about the same alkalinity as a $\frac{1}{35}$ normal alkali. If, however, this alkalinity be partly or completely neutralized, these particular organisms grow luxuriantly.

In the absence of further studies, all otherwise applicable hypertonic solutions of a given strength may be considered equally efficacious, and there therefore seems to be no advantage in using more expensive, complex, or less available solutions than sodium chloride or magnesium sulphate. As mentioned in the preceding theoretical discussion, there is no incontrovertible evidence that combinations of salts have advantages over a single salt in simple solution. The advantages of magnesium sulphate over ordinary salt solution have been mentioned, and this is probably the salt most commonly desirable.

In order to prepare or intelligently to order the preparation of solutions for purposes such as the one under discussion, it is frequently desirable to have some "rule of thumb" by which a satisfactory solution may be improvised even in the absence of access to really accurate weights and measures. Some

method of preparation which can be employed by the nurse in the absence of technical laboratory facilities is of value. An ordinary heaping tablespoonful of magnesium sulphate weighs about 16 gm.; an ordinary heaping tablespoonful of sodium chloride weighs about 30 gm. For practical purposes these values may be taken as approximately ½ oz. and 1 oz. respectively. As there are 32 oz. in the American quart, 4 heaping tablespoonfuls of magnesium sulphate or 2 heaping tablespoonfuls of sodium chloride when dissolved in 1 qt. of water will make approximately a 6 per cent solution. These amounts can be conveniently modified, of course, to give stronger solutions, on the one hand, or if occasionally so desired, weaker ones on the other; but the percentage of solutions to be used in the treatment of infection is not critical.

Possibly some such method as that used to deliver Dakin's solution to wounds, as described in connection with the Carrel-Dakin technique, might work very well as a method of application for hypertonic solutions, but such technique would be unnecessarily cumbersome for the smaller and simpler infections, and in the severest types of infections the Carrel-Dakin technique entire is probably still the method of choice.

Two simple alternatives are very obvious: either the infected wound may be dipped into the solution, or the solution may be placed upon the wound. The first method, or the method of immersion, is readily applicable only to certain limited portions of the body, especially to the hands and forearms, feet and legs. In order to immerse wounds involving most other parts of the body, not only would inordinately large amounts of solution be required, but in the case of acute infections two other factors would tend to militate against success: (1) the necessity of moving the patient's body about, and (2) the danger of further contamination of the infected wound ncident to immersing actually infected and potentially infected body areas together in the same bath.

In the case of infected wounds of the extremities the method of immersion or soaking may frequently be used very success-

fully; the solution into which the extremity is to be placed should, of course, be sterile. This condition of affairs may be insured either by using a previously sterilized container and solution or, more simply, by boiling the solution to be used in the container to be used. The unbroken skin of the extremity to be placed in the hypertonic solution should preferably be bacteriologically clean, especially in the case of acute infections; frequently this state of affairs will have been established either in connection with a previous operation or in connection with the preliminary mechanical cleansing of the infected area several times previously mentioned as essential. Any sterile gauze dressing that may have been placed about the affected area may and should be left upon the extremity during the process of soaking providing it be of such character and applied in such a way that it is readily permeable to its innermost recesses by the solution and providing further that it be not initially grossly soiled with wound secretions. The part played by gauze coverings in the control of infection is not only protective, but actually intrinsic, as mentioned in the preceding theoretical discussion, because, on the one hand, the meshes of the gauze exert capillary attraction for relatively inert pus, and on the other, serve as a meshwork support or trellis to which actively bactericidal leucocytes may attach themselves for support and from which they may launch an advantageous attack upon the invading bacteria.

In the use of the immersion method due attention should be paid to the principle of alternation of tryptic-antitryptic action in the wound. Periods of soaking should be alternated with periods of removal of the infected wound from the bath and rest. A two-hour period of intermission between successive soakings will ordinarily prove optimal, and from fifteen minutes to half an hour of actual soaking will usually not only prove ample for the purpose under discussion but will often exhaust the patient's strength as much as is permissible. However, the successful treatment of infected wounds, like the successful treatment of all other conditions in surgery, goes

not by the clock but according to certain individual variations which can be recognized and evaluated only by the critical eye of a trained and thoughtful attendant, and the matter of time must become, in the case of infections, subservient to the progress of the condition rather than the reverse.

Hypertonic solutions should, needless to repeat, be heated before use; a temperature of 110°F. is as cool as they should ordinarily be allowed to become, and they may be tolerated very much warmer than this especially by certain patients.

Gauze dressings covering wounds undergoing the immersion treatment should be changed in most cases not less frequently than once a day; in the case of foul wounds more frequent dressings are, of course, indicated. Repeated immersion may be permitted in the same solution providing the latter be sterilized by boiling between successive immersions and providing also that it does not become obnoxious through progressive contamination.

The soaking of infected wounds presents one disadvantage dependent solely upon mechanical considerations and one which may or may not prove serious depending upon circumstances. For the most obvious reasons any part of the body which is to be immersed in a solution must be made dependent and must be kept so as long as the process of immersion continues. The patient with serious infections of the extremities is, of course, not an ambulatory patient, and in order to allow actual soaking of parts of such a patient's body, the part in question must usually be allowed to hang over the edge of a bed, or at least such a position of the extremity must frequently be assumed that the blood supply to the member is embarrassed. Adequate arterial blood supply to, and adequate venous return from infected areas is the *sine qua non* of the effective treatment of infection, and no accessory treatment however painstakingly elaborated can at all compensate for failure to respect this basic principle. The immersion method will signally fail in the hands of thoughtless surgeons who

permit infected areas to become engorged with venous blood and infiltrated with edema.

The other alternative to the placing of an infected area in a solution is the placing of solution on the infected area. The latter expedient is, of course, more universally applicable than the former; not only may such a method be adopted for use on the extremities but also upon the trunk, head and neck. In the simplest case such a method would involve the simple pouring of the solution over the uncovered infected area, but such a procedure would usually not be feasible because of the almost unavoidable concomitant flooding with solution of bedclothing, splints, and other incidental and supportive paraphernalia. Furthermore, the value of gauze coverings which has been previously stressed is here likewise in point, and, accordingly, the expedient usually adopted consists either in saturating with solution dressings already applied to the infected area or in applying to the infected area dressings previously saturated with the solution. The former method may most conveniently be employed in the case of the extremities; these may be arranged, in suitable cases, over protective sheets of rubber or other impervious material so that any excess of solution which may be applied may overflow onto the protective sheet and be conducted away without soaking either the bed or indifferent parts of the patient's body. For infected wounds of the torso, head, neck, and usually also for the extremities the application of wet compresses is the more suitable method.

As compresses inevitably lose heat with considerable rapidity, and as the heat content of the compresses accounts for much of their therapeutic action either the compresses must be changed very frequently or else some method of applying external heat must be employed. It is usually impracticable to change hot dressings as often as they become cool, and consequently the usual expedient is to apply some additional source of heat external to the compress; this may consist of hot water bottles or an electric heating pad applied over the

dressing, an electric light globe suspended directly adjacent to the dressing, or perhaps best of all the electric light tent. Hot water bottles and electric pads are intrinsically objectionable partly on account of the additional weight which they impose on the tender wound area and partly upon the difficulty frequently encountered in keeping the temperature optimal and constant; the hot water bottle, of course, progressively loses heat, and the electric pad, though it maintains a constant temperature, may or may not be capable of maintaining an optimum temperature. The temperature within the electric light tent, on the other hand, may be so adjusted by cutting in or out of the circuit electric light globes so that the heat supplied is optimal and once adjusted tends to remain constant; the apparatus also removes the weight of the bedclothing from the wound.

As the therapeutic value of compresses depends to a considerable extent upon the hypertonicity of the solution used in preparing them, care should be taken to ensure that a sufficient amount of solution is employed to ensure bathing of the wound surface with solution, and this will sometimes entail pouring additional fluid directly onto the compress after the latter has been arranged in place. Furthermore, the principle of alternation of tryptic and antitryptic activity should be respected, and this necessitates particular attention to the renewal of compresses or addition of fluid, as the case may be, during the period assigned to the production of tryptic activity; during the period of antitryptic activity the dressings may, of course, be allowed to become dry.

Compresses should be changed as often as they become unduly soiled by wound secretions, and formal redressing of the wound, accompanied by careful inspection of all details of the treatment, should be performed by the attending surgeon not less frequently than once in twenty-four hours.

Even though compresses, soaks, or irrigations may be required in the treatment of infections for a period of several days, a 5 to 10 per cent salt solution is ordinarily sufficiently

hygroscopic to prevent softening and maceration of tissues providing only periods of rest be alternated with periods of active treatment, as has been described. The secretions from certain wounds harboring virulent infections, however, may occasionally tend to establish suppurative processes in the skin appendages of the healthy area surrounding the infected wound, and this tends to occur particularly when secretion is abundant and when the location of the infection favors friction between the skin surface and gauze dressings. In cases in which wound secretions are particularly copious and are therefore likely so to dilute any hypertonic solutions that may be applied as to reduce the hygroscopic effect of the latter to a minimum, it may occasionally be well not only to increase the percentage strength of the hypertonic solution slightly, but also to sponge skin areas adjacent to the wound with alcohol once or twice a day in order to destroy as many as possible of the surface bacteria contained thereon and also to withdraw water from the skin and thus prevent unnecessary maceration. The latter suggestion constitutes no exception to the rule that antiseptics should not be used *in* infected wounds; when using alcohol in this manner it is carefully prevented from entering the wound itself.

Wet dressings for application to infected wounds consist of several layers of gauze wrung out of the desired solution. In order to prevent secondary contamination of acutely infected wounds, the solution, the container for the solution, and the gauze used should, of course, be quite sterile and the manipulations incident to the wetting of the gauze and the transference of the compresses to the wound should be such as to insure continued sterility. It is usually possible to prepare and apply compresses by means of the intermediation of sterile instruments and thus to avoid time-consuming sterilization of the hands and the use of sterile rubber gloves, as only enough solution need be expressed from the compresses so that they do not drip. If, however, a situation arises in which instru-

mental manipulation of compresses does not suffice the hands must be prepared as carefully as for a formal operative procedure before they are allowed to come in contact with compresses or solution.

The temperature of solutions used for the preparation of compresses should be high enough so that, allowing for inevitable loss of heat during incidental manipulations, the finished compress as it reaches the wound is as hot as can be borne by the patient. Compresses built up out of several different gauze pads or squares can frequently be made to conform better to the contour of the infected part than a single, more bulky compress, prepared in one piece.

Over the finished compress there should be spread a layer of some material impervious to moisture; this may be a piece of thin rubber (rubber dam), a piece of mackintosh cloth (rubberized fabric), or a piece of oiled silk. This last layer serves the double function of preventing the escape of heat and moisture from the compresses and also of protecting the patient's garments and the bedclothing from soiling.

In the case of wounds which have passed the stage of acute infection, which show a tendency to become indolent, and are difficult to keep clean, it is often best to start a regime of daily or even more frequent ordinary tub baths. Such treatment is especially applicable to infected abdominal wounds of two or three weeks' standing which show little tendency to heal, infected amputation stumps which are not acutely inflamed, decubitus ulcers, leg ulcers and similar lesions. In these lesions the local resistance of the tissues has been built up to such a point that secondary acute infection occurs with difficulty and only very rarely, and the primary indication is for macroscopical cleanliness. No form of bed treatment can accomplish for these lesions what ordinary washing in quantities of warm water can achieve.

Stimulation of epithelial and granulation tissue: Clinically it would seem highly desirable in certain cases to have at one's disposal some special method or methods for the stimulation

of the two types of tissues upon the formation of which one depends for wound healing, epithelial tissue and connective tissue.

There are grounds for serious doubt, however, whether any such method or methods have been devised up to the present time. At all events no good scientific or experimental evidence has apparently been presented to show that any of the various substances or devices used for the purpose in question do in fact, accomplish that for which they were originally intended. The evidence for the value of special tissue stimulants is purely clinical, and there is little indisputable reason for believing that they accomplish more than can be expected from the use of the methods already described in connection with the control of sepsis, for the formation of new tissue and the control of sepsis are in reality but different aspects of the same process, new tissue being formed if and when physiological processes favorable to its growth have been established.

Undoubtedly stimulation of new tissue formation, whether of the connective tissue or epithelial variety, depends upon the overcoming of conditions unfavorable to such growth rather than upon any specific drug action.

As an epithelial stimulant the fat-staining dyes scarlet red and sudan III have been used with some success clinically for more than twenty years. Scarlet red in an 8 per cent ointment was recommended by Schmieden in 1908, and though there is apparently no experimental evidence that it is of value in promoting epitheliazation clinical experience would seem to justify its use. Davis recommends that the ointment be applied to the epithelium around wound edges only and that this be followed by the application of a bland ointment at the end of forty-eight hours.

For the stimulation of connective tissue local applications of certain drugs, notably silver nitrate and balsam of Peru, have enjoyed the favor of clinicians for many years and seem to have established their practical value sufficiently to warrant their use occasionally. Silver nitrate is used either in the form of a

strong solution (commonly a saturated solution) or in the form of the pure fused chemical, molded into sticks. Balsam of Peru is perhaps best applied in a menstruum of castor oil in the proportion of one part of the former to three parts of the latter.

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Chapter XIII

POSTOPERATIVE PERITONITIS

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Chapter XIII

POSTOPERATIVE PERITONITIS

Peritonitis may, of course, constitute the essential condition for which a patient primarily undergoes treatment, or it may, on the other hand, develop as a complication in cases under observation for other conditions whether in the preoperative or postoperative period. Furthermore, the development of peritonitis, though constituting fundamentally a surgical condition, may require early or late operative intervention or may never require formal operative procedures depending upon the variety of the condition which presents itself, and the convictions, knowledge, and experience of the attending surgeon. Perhaps no more distressing dilemma occurs in all surgery than that which develops in connection with cases of peritonitis in which the decision must be made whether to operate or to adopt or maintain conservative treatment.

1. Etiology of Peritonitis

One has but to recall the etiology of peritonitis to realize that almost any variety of the condition at all may be encountered both as a primary clinical entity and as a postoperative complication or sequela. In order of frequency the various causative lesions are:

(1) Perforations of the gastrointestinal tract, whether due to
   (a) traumata from within, as by foreign bodies, or traumata from without, as by gunshot and stab wounds,
   (b) ulcerations of the intestinal wall, whether peptic, malignant, or due to some bacterial agent like Bacillus typhosus, Bacillus tuberculosis, or Treponema pallida, and

(c) devitalization of tissue primarily due to interference with the blood supply, as in strangulation ileus, mesenteric thrombosis, or diverticulitis.

(2) Affections of the female genital organs whether
   (a) traumatic, as in childbirth injuries and abortions, or
   (b) bacterial, as in tuberculous, puerperal, and gonococcal infections.

(3) Perforative lesions of the biliary system and pancreas, whether
   (a) traumatic, as in gunshot and stab wounds, or
   (b) bacterial, as in suppurative cholangeitis and cholecystitis, hepatic abscess, and pancreatitis.

(4) Lesions of the urinary and male genital tract whether
   (a) traumatic, like rupture of the bladder, or
   (b) suppurative inflammations of the bladder, prostate gland, seminal vesicles, and kidneys.

(5) Miscellaneous traumatic and bacterial lesions in tissues adjacent to the peritoneal cavity, such as abscesses primarily of the retroperitoneal lymph nodes, extensions of suppuration from the pleurae and pericardium, and infections of the umbilicus in the newborn, and

(6) Hematogenous infections.

II. The Diagnosis of Acute Generalized Postoperative Peritonitis

The diagnosis of acute generalized peritonitis developing on the basis of some formal operative procedure is usually not difficult. Characteristically, if the medical attendant is familiar with the particular variety of operative procedure performed, some more or less obvious source of infection can be reasonably suspected, such as leakage from the stoma of a gastroenterostomy, contamination of the peritoneum during the removal of an acutely inflamed appendix, accidental instrumental perforation of the intestinal tract, or some other establishment

of contact with a septic focus. In a certain small percentage of cases no such obvious mechanism of contamination is evident, and this situation always makes an early diagnosis of the condition much more difficult.

Rapidly Overwhelming Peritonitis: The peritoneum possesses remarkable powers of resistance against infection, and suppurative peritonitis does not necessarily ensue even though considerable numbers of virulent organisms be injected directly into the peritoneal cavity, provided the continuity of the peritoneum is unbroken and the membrane itself is not devitalized by the previous presence of foreign bodies or the action of chemical toxins.

On the other hand, patients may die from the effect of toxic absorption from an intact peritoneum provided infectious organisms or their toxins be introduced directly into the peritoneal cavity in sufficient quantities. Frequently in the days before the advent of aseptic methods, large numbers of organisms having been introduced into the abdominal cavity at the time of operation, the patient was seen to develop within the space of a very few hours a profound toxemia accompanied by relatively few signs of peritonitis and to succumb within a day or two to the effects of toxic absorption.

Such a variety of fulminating peritonitis is seldom seen at present. It occasionally occurs (1) in cases of prolonged laparotomies accompanied by the infliction of severe trauma to the intra-abdominal viscera when associated with gross lapses in aseptic surgical technique and (2) also in those rare cases in which by some mischance the contents of a septic focus occurring outside of the peritoneal cavity is suddenly released into the abdomen. Patients suffering such mishaps rarely live longer than seventy-two hours; inasmuch as the condition is overwhelming in nature from the start, the diagnosis may remain in doubt unless elucidated at autopsy, and in any case the treatment matters little from the point of view of the final outcome.

III. Ordinary Postoperative Peritonitis

The mode of onset of ordinary postoperative peritonitis varies considerably. Amongst the most important determining factors is the nature of the source of the process. Certain processes are primarily irritative and only secondarily infective, e.g., contamination of the peritoneal cavity with such foreign fluids as gastric contents, urine, bile, and blood. Peritonitis thus caused is characterized by an acute onset of symptoms which are dependent upon peritoneal irritation. These symptoms are most severe when the fluid is most irritating, e.g., highly acid gastric contents, and least severe when the fluid is comparatively bland, e.g., blood and bile. Occasionally a most important consideration in differential diagnosis is the fact that such a peritonitis may develop either immediately after or at least within a very few hours of the operation, whereas peritonitis due to bacterial invasion undergoes a characteristic incubation period, or period of establishment, which is not ordinarily less than a full forty-eight hours. Although the variety of peritonitis due to various perforations begins essentially as a chemical peritonitis, it very definitely tends to proceed to frank suppuration, and in its later stages it usually differs in no essential particulars from the pyogenic form which will be discussed in greater detail presently.

A. Peritoneal Irritation: Peritoneal irritation produces certain rather typical symptoms and signs. In the initial stages the condition of shock tends to occur; this is characterized clinically as in all types of shock, by drawn facies, cold extremities, accelerated pulse, normal or subnormal temperature, and depression of blood pressure. The degree of shock is roughly commensurate with the amount of intra-abdominal spillage, taking always into consideration, as previously stated, the character of the fluid.

Other symptoms and signs of value in recognizing the process as an intra-abdominal lesion and localizing its position therein are the occurrence of:

(1) *Abdominal pain*, which may be intense in case irritation is extreme, which may be localized to the region of the abdomen primarily involved, but always tends to be diffuse and to have a certain maximal intensity in the region of the midabdomen or umbilicus, probably because this region corresponds to the topography of the root of the mesentery through which all pain impulses derived from the small intestine and its mesentery must travel regardless of the part of these structures primarily involved.

(2) *Splinting of the abdominal muscles*, which, on the one hand, produces a markedly thoracic type of breathing, and, on the other hand, conveys certain impressions to the senses, to the eye a picture of retraction of the abdominal wall and to the touch a sensation of rigidity which tends to be board-like in character and may or may not be most definite over the primary focus of the process.

(3) *Tenderness*, which is characteristically acute and may be generalized or localized to the area primarily involved.

(4) Possibly also *dulness* in the flanks provided the amount of effusion is considerable; however, because of the intense splint-like action of the abdominal musculature other signs of free fluid in the abdomen frequently cannot be satisfactorily elicited.

As this variety of lesion progresses it gradually assumes the characteristics of the more slowly developing peritonitis which is not secondary to gross peritoneal soiling, but rather arises as a gradual inflammatory reaction secondary to the growth of an initially small number of bacteria.

B. General Symptoms and Signs of Infective Peritonitis: As already mentioned, in case postoperative peritonitis develops as a result of contamination of the peritoneal cavity with only a relatively small number of bacteria at the time of operation, there characteristically ensues a period of some forty-eight to seventy-two hours during which exaltation of virulence and multiplication of the organisms occur, and few or no symptoms referable to the abdominal cavity are produced. During this incubation period patients may apparently undergo a normal postoperative reaction with only a slight elevation of the pulse rate and temperature and present no premonitory indications of the crisis about to precipitate itself; but more commonly such patients appear rather unduly toxic from the first, though the reason for the toxicity becomes apparent

only in retrospect when certain symptoms and signs about to be described become manifest.

In this variety of peritonitis abdominal pain is frequently minimal or rarely entirely absent, in marked contradistinction to peritonitis occurring preoperatively, and peritonitis due to perforation of intra-abdominal organs. On physical examination the patient with postoperative peritonitis usually appears restless and anxious, except in the later stages in which there may occasionally develop apathy and even delirium; the face is usually not flushed but cool and moist. The patient lies flat on the back and shows unwillingness to shift his position except for his head, which he frequently rolls from side to side. Due to fixation of the muscles of the abdomen, deep breathing is impossible, and consequently a shallow and moderately accelerated type of respiratory movement is characteristically noted. The patient both looks and feels sick.

Symptoms referable to the alimentary tract include:

1. Brownness and dryness of the tongue; in the later stages the lips may also become dry, fissured, and covered with sordes.
2. Nausea and vomiting which in the early stages are due to reflex irritation from the peritoneum, but in the later stages represent the development of paralytic ileus.
3. Suspension of intestinal activity which early manifests itself simply by obstipation, but later, as paralytic ileus develops, by abdominal distension secondary to accumulation of fluid and gas in the intestines.

Characteristic changes in the pulse rate and temperature require especial consideration. Of the two, the pulse rate is by far the most reliable indication of the extent and progress of the lesion. There invariably occurs an acceleration of the cardiac rate, but in the early stages before toxemia has become well established this acceleration may be very moderate indeed; in fact, a pulse rate of 80 to 90 to the minute is by no means incompatible with extensive peritoneal inflammation. However, within a period of twenty-four to thirty-six hours after peritonitis has become established septic absorption becomes more pronounced, the cardiac, and indeed the

entire circulatory musculature, loses tone, and from this time forward a mounting pulse rate can be taken as a definite indication of an extension of the process or a failing resistance on the part of the patient.

The temperature is a much less reliable guide in prognosis. Except in its terminal stages peritonitis rarely produces a fever higher than 103° or 103.2°F. Initially the temperature may even show a depression to subnormal levels in case very rapid invasion of the peritoneum occurs, as in the case of rupture of a septic focus such as an abscess or ulcer. In the established case a temperature between 100° and 101°F. when taken by rectum is the rule, and it should be standard practice to take the temperature of patients with peritonitis in this way because temperatures taken by mouth or axilla are apt to be misleadingly low.

In infective or purulent peritonitis the leucocyte count is invariably increased; the usual count varies between 12,000 and 20,000 leucocytes per cubic millimeter of blood. An inordinately high leucocytosis should make one suspicious of some other lesion, especially pneumonia. The percentage of polymorphonuclear cells characteristically furnishes a rather accurate guide to the virulence of the infection except in those cases in which the peritonitis is overwhelmingly virulent. A percentage of 80 or more usually indicates a severe infection. It should also be stated that extensive chemical peritonitis, such as produces the symptoms and signs of peritoneal irritation already described does not produce polymorphonuclear leucocytosis unless it becomes purulent; consequently, unless the leucocyte count shows at least 70 or 75 per cent of polymorphonuclear cells the peritonitic process is probably not of the purulent variety.

Abdominal tenderness and rigidity are as characteristic of postoperative as of preoperative peritonitis. Both of these signs are of some value in localizing the primary source of the process since they tend to be maximal in the part of the abdomen primarily or principally involved. Spreading tender-

ness and rigidity invariably indicate spreading infection, and consequently these two signs are of definite prognostic value.

The presence of fluid in the abdomen may be detected by the physical signs characteristically found in such a condition, i.e., (1) dulness in the flanks, which tends to shift on changing the patient's position, and (2) in case the amount of fluid is considerable and only few adhesions are present, fluctuation or a fluid wave. The amount of fluid is not, however, of any very great prognostic significance in the purulent variety of peritonitis. The presence of free gas in the abdominal cavity is, of course, always indicative of a perforation of the alimentary tract; the presence of free gas, however, is only rarely demonstrable even when perforations are known to have occurred.

IV. The Value of Secondary Operations in the Treatment of Diffuse Peritonitis

Much could be written on the subject of the value of operative procedures in the treatment of diffuse peritonitis. The question has been debated frequently and with fervor and probably only some revolutionary experimental or clinical finding could change the convictions of most surgeons on the subject. The present discussion makes no attempt to marshal the evidence either "pro" or "con" since the fundamental purpose of this treatise is not to give the indications for operative procedures but rather to outline the care of patients after the decision either for or against operation has already been made. In a general way, however, it may be stated that operative procedures for diffuse postoperative peritonitis are usually much less valuable than for preoperative peritonitis except in those cases in which such accidents as rupture of intestinal suture-lines, massive intra-abdominal hemorrhage due to slipping of a ligature about some arterial vessel, bile leakage, or some other source of peritoneal contamination, which can be definitely controlled by reoperation, can be

diagnosed with some surety. Within these limitations the value of such secondary operations, as indeed the value of primary operations for diffuse peritonitis, undoubtedly varies considerably with the personal element, and only as a result of considerable individual experience can one say with any degree of certainty whether conservative or radical therapy offers any particular patient the better prognosis.

The general subject of operative technique in case secondary operations seem indicated is, of course, quite beyond the scope of the present discussion.

V. The Conservative Treatment of Peritonitis

Once the decision has been made to adopt conservative therapy and postoperatively in cases subjected to secondary operation, certain very definite rules of treatment can be formulated regardless of the etiology of the peritonitis. The line of treatment determined by these rules is generally associated with the name of the late A. J. Ochsner, and justly so, not only because he was very largely instrumental in formulating them, but more especially because throughout a large portion of his active life he devoted much of his time and influence to popularizing them even at times when opposition was almost overwhelming. The Ochsner treatment is as follows:

(1) Possibly most important of all is the absolute interdiction of anything whatsoever by mouth. Nurses and occasionally even internes frequently construe this to mean "nothing but water" or "nothing but weak tea" unless specifically told to the contrary. The purpose of this measure, however, is to put the gastrointestinal tract at as nearly complete rest as possible and thus to favor the formation of protective adhesions while at the same time preventing the spread of the infection by the massage of intestinal loops one against the other as the result of peristalsis. For this reason water or any other substance whatever by mouth is strictly contraindicated.

(2) Peritonitic irritation tends to produce reverse peristalsis in the intestinal tract, and, because succus entericus is always present in the upper small intestine, to favor the regurgitation of intestinal contents into the stomach. The presence of such material in the stomach not only tends to excite normal peristalsis and thus to maintain intestinal activity, but because of its irritating properties it usually excites morbid massive spasms of the gastric musculature and a peristent kind of vomiting. This vomiting is not only physically exhausting to the patient but if frequently repeated tends very rapidly to produce a condition of systemic dehydration and hypochloremia. Accordingly, the prevention of vomiting is a matter of considerable importance. The best method of treating this variety of vomiting is the institution of gentle but thorough gastric lavage using large quantities of warm water. In the less amenable cases in which attacks of vomiting tend to recur again and again, it may become advisable to leave a small gastric or duodenal tube *in situ*, thus providing a ready vent for any secretions which subsequently may re-form in, or find their way into, the stomach or duodenum, but the mere presence of the tube may in certain cases provoke nausea and vomiting and may thus serve to defeat its own purpose.

(3) Food and water *per os* having been interdicted, it becomes incumbent upon the medical attendant to provide these substances parenterally or by rectum. Water is far more important than food, and if patients can be prevented from becoming dehydrated they can usually withstand deprivation of food remarkably well even for relatively long periods of time. Usually, however, both food material and water can conveniently be given in conjunction the one with the other in the form of dextrose solution. Four or five liters of solution during the course of each twenty-four hours should be introduced into the body of an adult person suffering from peritonitis, and the channel through which the administration should be made is a matter of relative indifference so long as it be not

introduced into the stomach; proctoclysis, hypodermoclysis, and intravenous infusion either individually, consecutively, or in conjunction may be employed depending upon circumstances, but when employing proctoclysis the attendant must make sure that the solution is actually absorbed and not evacuated into the bed, and when using intravenous infusion the possibility of postinfusion reactions must be carefully considered. The intravenous drip of Matas is particularly suitable in the severest cases. In those cases in which vomiting is profuse the danger of hypochloremia must not be forgotten, and in such cases the administration of sodium chloride solution either alone or in conjunction with glucose should be adopted, the amount and percentage strength of the sodium chloride in the solution depending upon the degree of hypochloremia as shown by chemical examination of the blood.

(4) Because of the difficulty of diagnosing and treating abscesses in the upper portion of the abdominal cavity as well as the intrinsic risk to life of such complications, and because diffuse peritonitis always tends to localize in the more dependent portions of the abdominal cavity providing the patient's resistance is adequate to prevent early death from toxemia, it is most important in all cases to favor the gravitation of the infected fluid contents of the abdomen to the region of the pelvis. In this locality not only can the clinical progress of the local reaction be much more conveniently and accurately followed because of the digital approach afforded by the natural body orifices, the rectum and vagina, but also in case it becomes necessary to drain purulent foci surgically the approach in this locality is much more direct. Accordingly the assumption and maintenance on the part of the patient of an exaggerated head-high, or Fowler's position, is of great importance.

(5) If the diagnosis has been definitely established and pain is severe the administration of morphine may be of value initially; prolongation of such medication is usually, however, not only unnecessary but also highly undesirable both from

the point of view of the possible development on the part of the patient of the morphine habit, but also intrinsically, since there is some very good evidence to support the view that morphine actually tends to stimulate intestinal movements. This matter, is of course, not in accord with the generally accepted view of the action of the drug, but it seems nevertheless to be fairly well established experimentally. Furthermore, morphine administration definitely tends to mask the symptoms of tenderness and rigidity upon which the medical attendant is partly dependent for his prognosis.

(6) Of very definite value in controlling pain is the local application of either heat or cold to the abdomen. Symptomatically both of these physical agents are of approximately equal value, and for this reason there are some who consider the question of which to use of little or no significance. On the other hand, many surgeons habitually use either the one or the other as a matter of routine, in spite of the fact that when pressed for some reason for so doing they may be unable to present any very good scientific basis for their preferences.

The application of heat has at least one very definite practical advantage in that it can be applied through the medium of a heat tent without adding a burden of physical weight to the patient's abdomen; indeed, the heat tent lifts the bedclothing away from the abdomen and thus relieves the patient of much of the weight which his body would otherwise be required to sustain. It has been maintained that local external heat is of definite advantage intrinsically in that it produces a reflex dilatation of the splanchnic vessels, though the evidence for this is not convincing. Probably the truth of the matter is that, aside from the symptomatic relief of pain, externally applied heat or cold serves simply to raise or lower the general body temperature, and whether to use the one or the other is a question which must be decided on this basis.

This conservative regime, though technically simple and theoretically easy of execution, is actually most difficult in

practice. The difficulty lies not so much in what is done but rather in the constant vigilant inactivity which is demanded of the medical attendant. The patient is apt to complain that he is being neglected, relatives and friends are almost sure to concur in this belief in case it is entertained by the patient, and usually even though the patient himself may be confident they adopt an attitude of distrust of the practitioner's skill and ability; added to this in certain cases will be an attitude of pessimism among the practitioner's own professional colleagues. In spite of this the medical attendant must maintain his therapeutic position for a number of days, frequently for a week or even longer, in the presence of a condition which shows no tendency to change for the better.

The administration of fluids and food by mouth must be interdicted as long as there are any signs of peritonitic activity, or until definite evidences of localization of the process become evident. Usually this involves prolongation of the regime until the patient's temperature has reached a normal level and has remained there for two or three days and the pulse rate has declined to and has become stationary at a normal level. If *per os* administrations are allowed too early an exacerbation of the process tends to occur immediately, and this invariably presents an indication for a return to the previous strict regime, a procedure which is not only discouraging to the patient and his friends but doubly trying to the medical attendant because it tends to shake his own confidence in the efficacy of the treatment. For this reason it is well for those not thoroughly familiar with this form of therapy to prolong the original treatment somewhat beyond the time at which they may think a relaxation of vigilance might be permissible.

The first article of diet to be allowed is, of course, water. This should be given very cautiously at first and in teaspoonful doses. Providing a twenty-four hour trial of this administration is well tolerated a very gradual addition of nutriment in the form of sweetened tea, beef tea, strained soups or

bouillon, and the like may be cautiously made until a soft, and later a full, diet is tolerated.

If the conservative treatment fails there is nothing further to be done and the patient gradually succumbs. On the other hand, if the patient rallies under such treatment the ultimate outcome of the case may depend to a very considerable extent on the alertness of the medical attendant in recognizing and properly treating certain complications about to be described under the heading of residual abscesses.

VI. Residual Abscess Formation

Although residual abscess formation tends to occur as a complication or sequela of diffuse peritonitis, and the institution of timely drainage would seem to be of value in minimizing such a development, these abscesses do occur with a considerable degree of frequency even in patients treated operatively, and therefore such lesions are by no means confined to patients treated solely by conservative measures. Thus Bancroft found secondary intra-abdominal abscess formation occurring in 1.6 per cent of nondrained cases of appendicitis, whereas 6.2 per cent of drained cases developed such abscesses.[1]

Furthermore, the development of intra-abdominal residual abscesses in cases in which diffuse peritonitis has not previously been recognizable, though a relatively infrequent occurrence, is one which may be, and probably is, more often overlooked than recognized, particularly in its initial stages. It has been estimated that in abdominal surgery a continuous postoperative fever in the absence of other recognizable causes for the same may be assumed to arise from wound infection either superficial or deep in about 90 per cent of cases, whereas the remaining 10 per cent will be represented by residual abscess formation of the type mentioned.

Several different types of residual abscesses have been described in accordance with their various sites and anatomical relations (Fig. 53):

A. The Douglas's or pelvic abscess
B. The lower right abdominal abscesses
   1. The ilio-inguinal
   2. The ceco-medial
      -superficial
      -deep
   3. The posteroparietal
C. The lower left abdominal abscesses
   1. Low (ilio-inguinal)
   2. High
D. The subphrenic abscess

A. THE DOUGLAS ABSCESS: In properly treated cases of diffuse peritonitis there is a very definite tendency toward the formation of residual abscesses in the most dependent part of the abdominal cavity, i.e., in the pouch of Douglas in the female (the rectouterine excavation), and in the rectovesical space (or rectovesical excavation) in the male. Abscesses in these locations are conveniently called collectively "Douglas abscesses." The mechanism by which they are produced depends upon the migration by gravity of peritoneal exudate to the most dependent part of the abdominal cavity, which when the patient is in the extreme Fowler position corresponds with the site of the abscess, and the development of a reaction in three stages (1) a simple local inflammatory reaction in the involved area, (2) the formation of protective adhesions which wall off the process from the general peritoneal cavity, and (3) frank suppuration within the accessory cavity so produced.

Unless especial care be taken to recognize the development of such an abscess it may be completely overlooked, because the portion of the peritoneal cavity in which it occurs is at a considerable distance from the surface of the body so that local evidences of inflammation are not manifest, and furthermore because the pelvic peritoneum is far more tolerant to irritation than the abdominal peritoneum, and consequently the symptoms occasioned by the presence of an irritative lesion in this locality are apt to be minimal. When untreated these

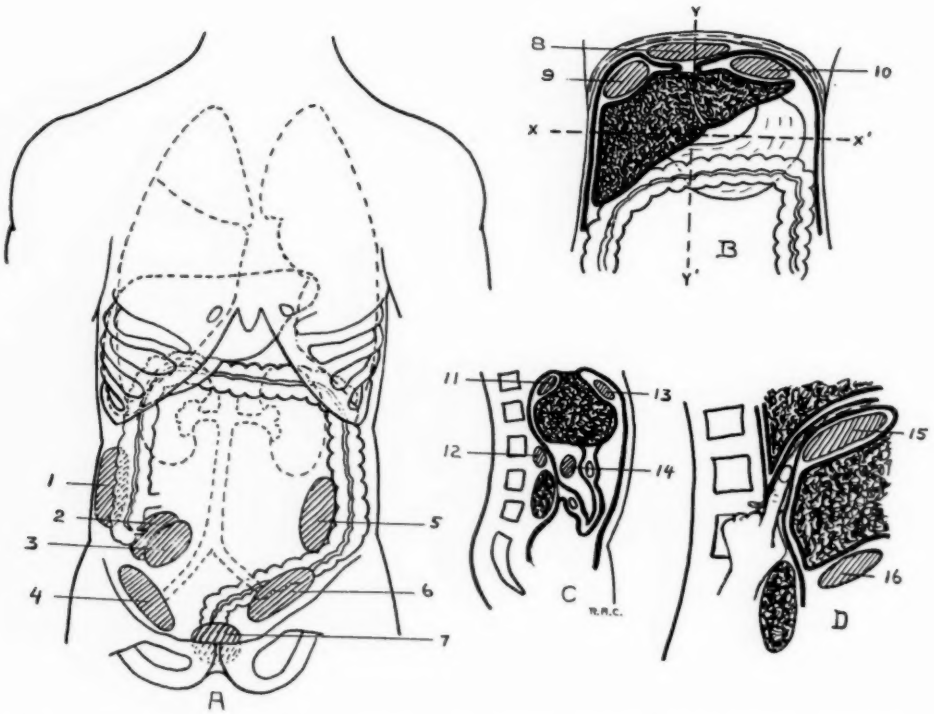

FIG. 53. The more important and common locations of intraperitoneal residual abscesses.

Insert A. Anteroposterior view of various locations of residual abscesses in lower abdomen.

On the right are the following abscesses:

1. ..... posteroparietal
2. ..... cecomedial (deep)
3. ..... cecomedial (superficial)
4. ..... ilio-inguinal

On the left side of the abdomen are the following abscesses:

5. ..... high left abscess
6. ..... low (ilio-inguinal) left abscess

In the pelvis is:

7. ..... Douglas abscess

Inserts B, C, and D represent some of the varieties of upper abdominal or subphrenic space infections.

Insert B. Anteroposterior view of the group of subphrenic abscesses which occur between diaphragm and superior surface of liver; in the interest of completeness the location of the extraperitoneal abscess which occurs in the cellular space between the layers of the coronary ligament has been included:

8. ..... extraperitoneal abscess
9. ..... anterior and posterior right upper abscesses
10. ..... left upper abscess

The dotted lines X-X' and Y-Y' represent the division of the subphrenic space into four subdivisions (Nather and Ochsner).

abscesses tend to rupture into the rectum or vagina and drain, and thus in a considerable number of cases to progress to spontaneous resolution. In such cases, unless the lesion has previously been diagnosed, the passage of a small amount of pus per rectum or vagina may be overlooked, and the true status of the case may never be recognized.

For this reason it is imperative that the medical attendant in charge of a case of diffuse peritonitis undergoing conservative treatment make frequent digital examinations to determine the condition of this part of the peritoneal cavity. Of course it is true that the Douglas abscess is not frequently entirely symptomless. Usually the development of the abscess has a definite effect on the temperature; postoperatively the temperature may remain elevated in spite of treatment or it may undergo an early return to normal followed by a subsequent elevation at the end of one or more days; occasionally suppuration is delayed for relatively long periods of time and secondary elevation of temperature may occur only after the lapse of several weeks. Martin[2] and Melchior[3] have reported cases in which such abscess formation occurred only after months or years. Associated with the pyrexia in all cases is a leucocytosis. Pain is not usually a prominent symptom, and unless the possibility of the development of this particular condition be kept constantly in mind some other cause will be usually held responsible for such abdominal pain as there is.

Insert C represents a lateral view of right-sided subphrenic abscesses (both upper and lower groups); in the interest of completeness the extraperitoneal perinephritic abscess has been included:

11. ..... right upper posterior abscess
12. ..... (extraperitoneal) perinephritic abscess
13. ..... right upper anterior abscess
14. ..... right lower abscess (abscess in Morrison's pouch)

Insert D represents a lateral view of technique of Nather and Ochsner's extraperitoneal approach to the right-sided subphrenic abscesses. The finger peels away the peritoneum from the inferior aspect of the diaphragm and tears its way into the perinephritic space:

15. ..... right upper posterior space
16. ..... right lower space or the extraperitoneal space between the leaves of the coronary ligament as may be desired without invading the general peritoneal cavity.

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Locally no symptoms or signs develop so long as the process consists of a mere collection of inflammatory exudate producing mild peritoneal irritation. As adhesions begin to form as a result of this reaction, however, and especially in the later stages when a definite abscess develops, a rather characteristic train of clinical manifestations tends to become apparent.

The symptoms experienced during these later stages of the formation of Douglas abscesses are dependent partly upon extension of the process to neighboring organs and partly to the mechanical presence of a mass in the cul-de-sac. The organs primarily affected are the bladder and the rectum.

In males bladder irritation can be caused more directly than in the female, obviously because in the female the bladder is separated from the rectum by the uterus and adnexa; mechanical pressure, however, even in females may, of course, be transmitted to the bladder indirectly. The symptoms of bladder irritation are frequency and urgency of micturition, accompanied rather characteristically by a sense of fullness or pressure in the region of the bladder.

The effects on the rectum may be either mechanical or irritative and secondary to the inflammatory process. In both sexes the inflammatory collection is, of course, directly anterior to the rectum and causes a certain amount of direct pressure on the rectum and sigmoid; this may give rise to a sense of fullness in the rectum accompanied by constipation. The usual effect, however, is an extension of the inflammatory process to the rectum and the outpouring of inflammatory exudate into the lower bowel with the consequent production of diarrhea. So characteristic is the production of diarrhea according to this mechanism that the medical attendant will do well to consider the possibility of Douglas abscess formation in connection with any laparotomy patient who develops postoperatively an unexplained diarrhea.

Rectal examination confirms the diagnosis, and, as previously stated, should be performed not less frequently than every two days on all patients undergoing treatment for diffuse

peritonitis. The characteristic period of development of Douglas abscess is from five to six days in patients who have been submitted to laparotomy, and for this reason the medical attendant should be particularly on the alert to recognize the development of the condition about the end of the first week.

In the early stages, in which there is present merely a collection of fluid, rectal examination cannot, of course, be expected to be of any value. As adhesions begin to develop, however, and particularly when inflammatory processes begin to occur in adjacent structures the examining finger is able to detect a bulging mass on the anterior rectal wall at about the extreme limit of palpability, and the sign of tenderness can also be elicited by exerting pressure over the mass. The mass is at first hard and indurated and perhaps can be felt to increase in size from day to day. The mucosa of the bowel in the region of the developing abscess rather early conveys to the examining finger the sense of abnormal thickness and succulency. As definite suppuration begins to occur the sphincters at the anus tend to undergo paresis; the resulting relaxation can sometimes be appreciated visually and always manually; the indurated mass in the rectum at this time begins to undergo softening at its center, and this softening tends to progress to actual resorption and rupture of the intervening tissue unless a surgical opening is made for the purpose of drainage.

The process of formation of a Douglas abscess should be followed with careful watchfulness, and surgical intervention should not be invoked too early because a certain percentage of such abscesses tend to undergo spontaneous resolution. Furthermore, too early operative intervention may prove disastrous because, unless protective adhesions have had time to form between the abscess cavity and the general peritoneal cavity, drainage of the abscess involves opening directly into the latter cavity, a procedure which, in the very nature of the case, could hardly fail to result fatally for the patient. During the period of preliminary observation some benefit may possibly be expected from the local application of heat either

in the form of a hot water bottle or hot compresses to the perineum, or the continuous irrigation of the rectum through a special irrigating rectal tube or catheter.

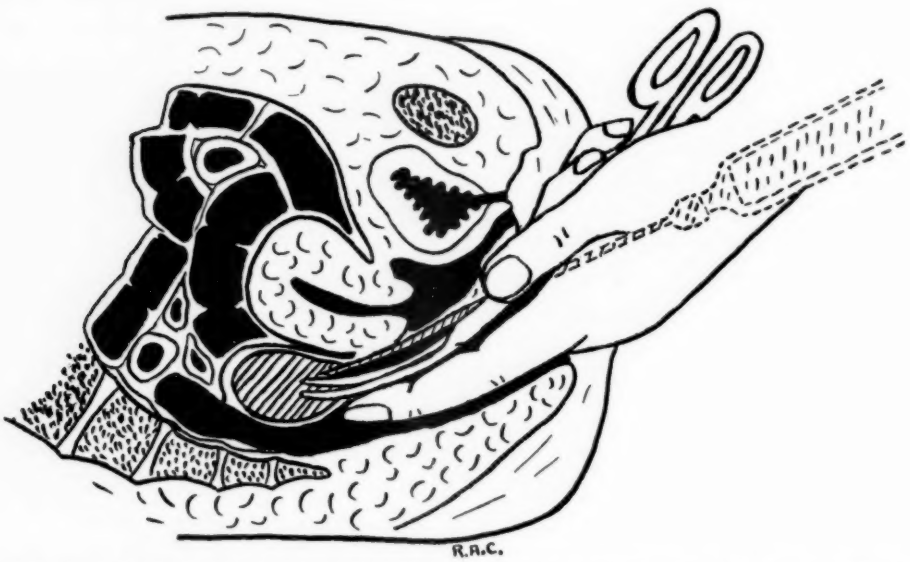

FIG. 54. Suggested technique of opening an abscess in cul-de-sac of Douglas. Abscess is drained through rectum. The gloved finger is first introduced into the rectum and locates point of maximum fluctuation; a long needle is then introduced along the finger as a guide and is pushed into abscess cavity (needle is shown in dotted lines). As soon as pus is discovered and can be aspirated through the needle a curved Mayo scissors is introduced along the needle as a guide and the points are forced into the abscess cavity. Opening thus made is enlarged by opening the scissors and withdrawing them.

As soon as fluctuation can be detected operative drainage is indicated. This may be performed under local infiltration or sacral analgesia, and although the approach in the female may be either through the vagina or the rectum, in the male, of course, only the rectum is available. The operation itself is very simple and should be performed as follows:

An aspirating needle is introduced into the inflammatory mass, using one finger in the rectum or vagina as a guide; as soon as pus has been discovered an incision is made along the needle with a sharp pointed scalpel or bistuary. This procedure is then followed by the introduction of the closed points of a Mayo scissors or the points of an Ochsner forceps into the

opening thus made and the subsequent enlargement of the tract by opening and withdrawing the instrument according to the method of Hilton (Fig. 54). A drainage tube of soft rubber is then inserted into the abscess cavity and is left sufficiently long to project through the anal sphincters. A "T" binder completes the dressing. The tube is usually left in place until the bowels move spontaneously whereupon it comes away and usually does not require subsequent reinsertion.

B. THE LOWER RIGHT ABDOMINAL ABSCESSES: The subdivision of the lower right abdominal abscesses into ilioinguinal, cecomedial, and posteroparietal varieties is of some significance for descriptive purposes, but is of relatively little clinical importance not only because such abscesses have a common etiological background but also because they all present similar clinical characteristics and tend anatomically to overlap or combine.

These abscesses are usually secondary to suppurative processes within the appendix, but occasionally represent complications of infectious processes primarily in the cecum, colon, right side of the spine, and the pelvis.

Because of the modern tendency to treat infections of the appendix by early appendectomy, because of the recognition of the value of the Fowler position in the treatment of diffuse peritonitis secondary to appendicitis, and because of the tendency to provide early drainage in suppurative appendicitis. residual abscesses are less apt to occur in the region of the cecum than elsewhere. Clairmont and Meyer[4] were able to report only 8 frankly paracecal abscesses and only 3 additional abscesses, located partly on the right side and extending to the suprapubic region, in a series of 1179 cases of acute appendicitis. Cutler,[5] however, reported 10 such abscesses in a series of 18 peritoneal abscesses, or 55 per cent.

The diagnosis of abscess formation in this locality is usually relatively easy, perhaps easier in those cases in which the abscess develops after appendectomy than in other cases. The usual history is that at the time of operation evidences

were found that the inflammatory process had already extended somewhat beyond the limits of the appendix itself, although drainage was not considered necessary. The postoperative reaction of the patient in these cases in not quite normal; the pulse rate undergoes some acceleration, the temperature does not return to normal as it should in uncomplicated cases, the patient appears ill and complains of an unusual amount of pain in the right lower quadrant of the abdomen. Usually the surgeon's first thought is of the development of a seroma or a hematoma, or, if several days have already elapsed since operation, of a localized infection, in the wound. Examination at this time reveals no definite point of tenderness along the line of the incision, such as would be characteristic of a stitch abscess, but a diffuse tenderness and rigidity of the entire right lower quadrant of the abdomen; indeed, if more than two or three days have elapsed since operation the wound should not be tender at all, and the diffuse tenderness surrounding it should make the diagnosis of intra-abdominal infection rather clear.

At this time a definite mass in the affected area may or may not be palpable depending upon the reaction provoked by the infective process. In the early stages of suppuration there is merely an outpouring of inflammatory exudate which, of course, cannot be appreciated by physical examination. As time goes on, however, adhesions tend to form and draw intestinal loops and omentum together in a mass, thus tending to localize the process and to prevent the development of a diffuse and spreading peritonitis; this matting together of the intra-abdominal contents may be palpable for some time before actual suppuration occurs.

As the peritoneal exudate becomes purulent and particularly if protective peritoneal adhesions are not formed with sufficient promptness to prevent the process from spreading, the characteristic symptoms and signs of diffuse peritonitis become increasingly evident. As definite abscess formation occurs the patient's fever usually becomes somewhat higher,

the localizing symptoms and signs, particularly the presence of a local mass, become more pronounced, and if the patient be not subjected to surgical drainage, local surface edema, swelling, and the other signs of localized inflammation may even appear later.

The proper treatment for such abscesses is rather obvious. In the early stages before protective adhesions have been formed every effort should be made to prevent the process from spreading, and the Ochsner method is the treatment of choice. The patient is placed in the Fowler position, the intestinal tract is put at complete rest, the patient himself is kept as quiet as possible, and local applications are provided, particularly the application of heat in the form of a heat tent or hot moist compresses. No attempt should be made to drain the process until the surgeon is sure that the process has become completely encapsulated from the general peritoneal cavity, and this usually takes several days. As soon as a definite abscess has developed surgical drainage is performed the utmost care being taken to avoid opening into the general abdominal cavity.

c. The Lower Left Abdominal Abscesses: Abscesses in the left lower quadrant of the abdomen develop but rarely. Usually these abscesses are secondary to appendicitis, but may occasionally follow traumatic or other perforations of the small intestine or may represent retrograde extensions from the pelvis. In cases of *situs inversus viscerum* the mechanism of production of the left-sided abscess is of course identical with that of the right-sided abscess in normal individuals, but left-sided abscesses occur as a result of appendicitis even in individuals with normally placed viscera. In such cases, according to Sprengel,[6] the complication may develop in either one of two ways: (a) either a Douglas abscess may form an intermediate link, the left-sided abscess arising by secondary extension from the pelvis, or (b) when some interference to the normal progress of inflammatory exudate into the pelvis occurs at the pelvic brim, this exudate may make its way

directly across the abdomen and localize in the region of the sigmoid flexure of the colon.

From Clairmont's clinic have come two interesting studies of this unusual form of abscess, the first by Nather and Ochsner[7] covering a period of four years and 700 cases of acute appendicitis with 9 instances of lower left-sided abscesses, the second by Clairmont and Meyer[4] observed during a period of five years including 1179 cases of acute appendicitis in which there were 12 cases of left-sided abscess and 7 cases of left-sided "infiltration."

The symptoms and signs of these left-sided abscesses are very similar to those occurring on the right side of the abdomen except for their position. The diagnosis of such infections when they occur after appendectomy is perhaps not so easy because the surgeon may at first be inclined to question the validity of the operative diagnosis, thinking that possibly some associated abnormality on the left side of the abdomen was inadvertently overlooked. The treatment of left-sided abscesses differs in no essential respect from the treatment of corresponding lesions on the opposite side of the abdomen, and, therefore, no separate discussion is required.

D. THE SUBPHRENIC ABSCESS: Etymologically subphrenic abscesses could be understood to include all abscesses below the diaphragm, but actually only those collections of pus which occur in more or less close apposition to the diaphragm are usually included in such a classification. According to Freeman[8] and Winslow[9] only those abscesses which occur immediately below and in actual contact with the diaphragm at some point should be designated as subphrenic.

The subphrenic abscess has been defined by Godlee[10] as "any collection of pus or pus and gas, the whole or any part of which intervenes between the diaphragm and the structures [normally]* in contact with its lower surface."

In the interests of clarity it is probably best to describe certain arbitrary anatomical boundaries within which all

*The brackets are mine.

abscesses can be called subphrenic, and the colon and transverse mesocolon may conveniently be considered as constituting an inferior limit, the diaphragm being, of course, the universally accepted superior boundary. Accordingly, the subphrenic abscess may be defined as any abscess occurring in the upper abdomen between the diaphragm above and the transverse colon and transverse mesocolon below.

Martinet[11] and Bernard[12] were pioneers in the description of the topographical anatomy of the subphrenic region. Nather and Ochsner[7] amplified and modified the description of these investigators as follows:

The liver divides the subphrenic space into an upper and a lower portion and the falciform ligament into right and left portions, making four spaces in all.

(1) The right upper space, between the liver and the diaphragm and to the right of the falciform ligament, is subdivided into two minor spaces:
   (a) the anterior, which is anterior to the right triangular ligament, and
   (b) the posterior, which is posterior to the right triangular ligament.
(2) The right lower space, which is below the lower surface of the liver and above the transverse colon and thus corresponds with the space known as Morrison's pouch.
(3) The left upper space, which is between the left lobe of the liver and the lower surface of the diaphragm.
(4) The left lower space, which lies between the left lobe of the liver and the transverse colon and which is subdivided into two minor spaces:
   (a) the anterior, which lies anterior to the lesser omentum and the stomach, and
   (b) the posterior, which corresponds with the lesser peritoneal cavity.

In addition to these spaces another is sometimes recognized:

(5) The perisplenic space, which surrounds the spleen.

Etiology: Subphrenic abscesses develop in the vast majority of cases as a complication of diffuse peritonitis, or stated in a slightly different way, by extension from some focus of infection within the abdominal cavity.

Formerly observers were in rather general agreement that appendicitis was the most common antecedent lesion. Thus Fagge[13] believed, in 1909, that appendicitis accounted for 50 per cent of all cases of subphrenic infection. Harsha,[14] in 1919, asserted that 9 out of 10 cases arose in this manner. Ross[15] on the basis of a series of 3391 consecutive cases of acute appendicitis judged that subphrenic abscesses occurred in from 0.5 to 1 per cent of all cases of acute appendicitis. Fifield and Love[16] found 38.4 per cent of 78 cases of subphrenic abscess secondary to acute appendicitis, and Clendening[17] found 66 per cent of his series of cases secondary to acute appendicitis.

The mechanism by which extension occurs can be understood from a consideration of certain simple principles of hydrostatics as shown long ago by Bernard.[12] When a patient lies flat on his back in bed the two most dependent portions of the peritoneal cavity are the subphrenic space above and the pouch of Douglas below; between these two dependent pouches there occurs an elevation consisting of the thick soft parts overlying the normal lumbar curve and surmounted by the kidneys and the perinephritic fat. Coffey[18] found that the upper pouches in the region of the loins were capable of holding more fluid than the pelvis and that in order to drain the flanks of the fluid a patient's body must be elevated to such an extent as to make with the bed an angle of 60 or even 70°. The direction in which exudate arising in the region of the appendix drains, whether toward the subphrenic depression or toward the pelvis, depends therefore upon two factors: (a) the position of the appendix, and (b) the position of the body with respect to the bed. When the appendix occurs retrocecally or retroperitoneally, and posteriorly or laterally to the colon, and when its base is unusually high due to incomplete rotation of the colon, peritoneal exudate from it tends to flow upward, and subphrenic abscess tends to occur. When, on the other hand, the appendix is in its normal position or when it dips over the brim of the pelvis, fluid flows downward

and the development of a Douglas abscess is favored. Furthermore, during the period in which exudation occurs in fluid form and before adhesions have been developed to limit its migration from place to place, the position of the body is of the utmost importance in determining the position at which abscess will subsequently occur. With the body elevated to an angle of 70° virtually all free fluid within the abdominal cavity gravitates into the pelvis, and accordingly subphrenic infection is not apt to develop.

Recently many observers have come to believe that ruptured peptic ulcers account for just as many subphrenic abscesses as appendicitis. Thus Peery,[19] collecting a series of 493 subphrenic abscesses from the literature, showed that the appendix was the origin of the infection in 25.3 per cent of cases, but that the stomach accounted for 23.1 per cent and the stomach and duodenum together for 26.3 per cent of cases. Fagge,[13] who in 1909 believed that 50 per cent of subphrenic abscesses were due to appendicitis, was convinced in 1921 that nearly 80 per cent of such infections were secondary to gastric or duodenal ulceration. In Fifield and Love's[16] series of cases 20 per cent of subphrenic infections were secondary to ruptured peptic ulcer.

Probably it is safe to assume that appendicitis and ruptured peptic ulcer each account for about an equal number of cases, about 25 per cent each. Undoubtedly, furthermore, appendicitis now accounts for far fewer cases than formerly, not only because appendicitis is now diagnosed and treated more promptly than formerly but because more and more attention is being paid to the conservative treatment of peritonitis.

About half of the cases of subphrenic abscess are secondary to other lesions than appendicitis and peptic ulcer. No particular lesion, however, seems to account for any considerable number of cases. In the series collected by Peery[19] suppurative processes in the liver and bile passages were responsible for 8.8 per cent of cases, but aside from this no particular lesion seemed to be responsible for more than 5 per cent of the cases.

Among the miscellaneous lesions are suppurations in the spleen, kidney, and pancreas, tuberculous processes in the ribs and spine, empyema, pelvic suppurations, including tubal infections, traumatic lesions such as bullet and stab wounds, and a number of other processes such as hydatid cysts.

The bacteriology of subphrenic abscesses is variable and depends in part upon the manner of production. Abscesses developing on the basis of an antecedent appendicitis usually contain B. coli and streptococci, and those secondary to a ruptured peptic ulcer often contain staphylococci in addition to B. coli and streptococci. Abscesses secondary to tuberculous processes in the ribs or spine may or may not contain tubercle bacilli, and abscesses which represent extensions from a primary empyema may contain either tubercle bacilli or pneumococci. Douglas[20] has reported a case of actinomycotic subphrenic abscess.

Diagnosis: Recognition of the development of subphrenic abscesses is not particularly difficult if the possibility of such a complication is considered. There are, however, usually no localizing signs or symptoms, though there may be a sense of epigastric fullness or distress and occasionally some pain on deep breathing. The classical clinical picture described by Barlow, Leyden, and others many years ago, above the liver dulness a tympanitic zone represented by free gas in the peritoneal cavity, and above this a zone of dulness due to a pleural exudate, is not actually of much value because free gas is present in the peritoneal cavity in only about one-third of the cases of subphrenic abscess, and, furthermore, the tympanitic zone may be simulated by a highly placed, gas-filled, transverse colon.

In the typical case, such as that following appendectomy, the symptoms of the condition may follow within a few days or may be delayed for several weeks; usually, however, in from one to two weeks in a patient who has not been convalescing well the following will be noted:

General Symptoms: The temperature, which may or may not have been normal previously, now rises, or the pulse rate rises in the absence of corresponding increases in the temperature. Anorexia develops, diaphoresis becomes exaggerated, and prostration ensues.

Physical Examination: The usual methods of physical examination often reveal little evidence of localized inflammation, at least in the early stages. As time goes on definite localized tenderness may be recognized on deep pressure, and minor degrees of superficial edema may be noted over the involved area. There is usually no swelling or other evidence of localized inflammation but indirect evidences of the inflammatory process may be elicited: limitation of respiratory motion, especially on the affected side, dulness at the base of the lung on the affected side due either to the presence of a pleural exudate which is usually sterile, or to compression of the dependent lung tissue by a highly arched diaphragm.

Pain on deep concussion and displacement of the apex of the heart to the left are valuable signs when present, but are not usually found.

The leucocyte count is usually high, 25 to 30,000 with a polymorphonuclear count of over 85 per cent.

As an aid in diagnosis *x*-ray examination is of the utmost importance. The diaphragm on the affected side will be found highly arched, usually rounded, and relatively immobile. The normal excursion which is from 2 to 3 in. in amplitude is often reduced to an excursion of a fourth of an inch or so; occasionally the costophrenic angle will be clouded or obliterated by accompanying fluid in the chest or by bronchitis in this area. The presence of a gas bubble just under the dome of the diaphragm is certainly important when present, but such, as previously mentioned, is very rarely found. It must be remembered that the roentgenological picture of a high, rounded, fixed, dome-like diaphragm is not always indicative of intra-abdominal pathology. It is in certain cases due to

paralysis of one side of the diaphragm; in such cases it is usually not accompanied by symptoms of any kind.

Diagnosis is clinched by aspiration in those cases in which the condition is suspected but cannot be otherwise confirmed. Exploratory aspiration may, of course, be performed either by introducing the trocar horizontally between the ribs or from below the ribs upward; these procedures have very serious disadvantages in that in the former approach the pleural cavity, which is apt to be sterile, is invaded, whereas in the latter approach sterile portions of the abdominal cavity may be contaminated. The approach which is considered least dangerous is described by Nather and Ochsner; it consists in introducing the aspirating needle in the midaxillary line at the level of the spine of the first lumbar vertebra, the point being upward and backward at an angle of somewhat less than 45°; during the aspiration mild continuous suction should be applied to the needle in order that the point may not pass through an abscess cavity undetected and thus infect healthy tissue beyond. Several different punctures or redirection of the needle in various different directions may be required before results are obtained. Naturally this approach is principally suitable for such collections of pus as occur in the right subphrenic spaces; the abscesses which follow appendectomy are characteristically accessible by this method because they usually develop either in the right upper posterior or the right lower spaces.

Treatment: Two classical operative approaches have been described in connection with the drainage of subphrenic abscesses, (1) the transpleural, and (2) the transabdominal. Both of these are open to the objection previously mentioned in connection with aspiration, viz., that in the process of reaching the collection of pus virgin cavities may be traversed. Nather and Ochsner[7] have described an approach not open to these objections and therefore highly desirable.

An incision is made directly over and parallel with the right twelfth rib and after the latter has been exposed, subperiosteal resection of the entire rib is performed to within 4 cm. of the

midline. Transverse incision of the musculature below the former location of the resected rib and at the level of the first lumbar spinous process is now made and careful dissection is carried down to the renal fascia. This fascia having been identified, dissection with the operator's finger is carried upward, and the peritoneum lining the lower surface of the diaphragm, which is continuous with the aforementioned fascia, is carefully peeled away from the lower surface of the diaphragm. The edematous condition in which the peritoneum finds itself as a result of the adjacent inflammation facilitates this process. When the dissection has been carried upward in this manner well onto the dome of the liver, abscess cavities may be sought by the sense of touch or by the exploratory needle (a) in the adjacent subhepatic spaces (right superior posterior, right superior anterior, or right inferior), as well as (b) above the diaphragm (pleural cavity), (c) and in the liver substance. When the abscess cavity or cavities have been thus identified they are torn open by the finger tip, and drainage is thus established to the exterior without contaminating either virgin pleural or peritoneal cavities.

It is important to remember in this connection that abscesses following appendicitis are frequently multiple, one above and one below the liver (Maydl[21] and Piquands[22] 53 per cent, and Bernard[12] 60 per cent of cases).

Prognosis: The prognosis in cases of subphrenic abscess is always grave; when death occurs it is usually due to sepsis. Although it is possible for spontaneous healing to occur either by resolution, as in the case of tuberculous abscesses, or in other cases by rupture and drainage of the abscess either into some adjacent hollow viscus or onto the external surface of the body, cases treated expectantly or conservatively show a 55 to 90 per cent mortality. Sonnenberg[23] places the mortality in cases not subjected to operation at 55.5 per cent, Sachs[24] at 71.5 per cent, and Elsberg[25] at 82 per cent. The same observers in cases subjected to suitable operative procedures place the mortality respectively at 42, 37.5, and 22 per cent.[19] Although

in fulminant cases patients may succumb in a few hours or a few days, in the less virulent varieties of infection slow septic absorption may occur over a period of weeks or months without causing death. In cases in which operative drainage is unduly delayed the mortality is higher than otherwise; thus Sachs[24] found a mortality of only 13.5 per cent in those cases drained within three weeks whereas in patients operated upon after this period of time the mortality was 50 per cent.

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